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VIEWS, NEWS AND INTERVIEWS.

Mr. Alfred Hendricks, representing Erastus Wiman and the receiver, stockholders and creditors of the Electric Power Company, of Staten Island, N. Y., has sailed for England to make a personal explanation of the circumstances leading up to Mr. Wiman's arrest, and to reopen negotiations for the transfer of the Electric company's works to an English syndicate.

The State Railroad Commissioners' office at Albany, N. Y., is being flooded with applications from motor inventors asking for an opportunity to have their appliances tested in case a certain measure meets with the approval of the legislature. This is an application from the Metropolitan Traction Company, of New York, to have the Board of Railroad Commissioners act as judge to name the most practical electric or other motive power for street railroads. The company offers a prize of $50,000 for the Railroad Commission to award. As soon as the communication was received by the Railroad Commissioners asking them to act as judges, it was submitted to the legislature, and is now being considered by the respective Railroad Committees of the two houses. As yet it has not been acted upon. Since the purpose of the company in making the award became known, applications have been coming in to the Railroad Commissioners from all parts of the world. The last application is No. 260. New York city furnishes more than any other of the inventions, but they have been received from all the States of this country, from Rome, Italy, France, Germany, Canada and England.

A bill extending the terms of office of the Board of Electrical Control, of New York city, for three years has been introduced in the Senate by Senator O'Donnell.

The manufacture of mica plates is described as follows by *La Lumière Electrique:* Small pieces of mica, the largest of which might be about 40 square centimetres, are made to fall through a long tube into a small tank mounted on wheels; into this tank is pumped a cement consisting of gum lac dissolved in alcohol. After having mixed up a sufficient quantity of the mica and cement to make the necessary thickness of plate, a piece of sheet-iron is placed on the surface; this operation is repeated until the tank is full of layers of cemented mica separated by sheet-iron plates. The whole is then subjected to gentle heat and compressed, excess of cement being allowed to flow away. The mica plates, when finished, can be lifted away from the tank. By the above method mica plates can be manufactured which are easy to work and of sufficient strength for ordinary purposes.

The Multiphase Transmission Plant at Sewall's Falls, N. H., Started.

AN INTERESTING INSTALLATION.

The Concord, N. H., Land and Water Power Company has for some months past been engaged in installing the first commercial multiphase transmission plant in the United States of the same character as the one used in the famous experimental tests between Lauffen and Frankfort, Germany. The details of this plant were described at some length in the ELECTRICAL REVIEW for October 14, 1893. The accompanying illustrations show an interior view of the plant

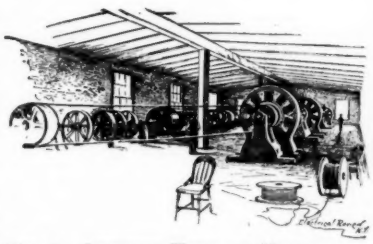


FIG. 1.—INTERIOR VIEW OF MULTIPHASE TRANSMISSION PLANT AT SEWALL'S FALLS, N. H.

and the dam which furnishes the water-power at Sewall's Falls. This dam is 500 feet long, has a 22 foot head and a normal average capacity of 5,000 horse-power. The plant has a capacity of five pairs of turbines, giving 2,000 horse-power.

At 10 o'clock A. M. on February 28 the water was let into the canal for the first time,

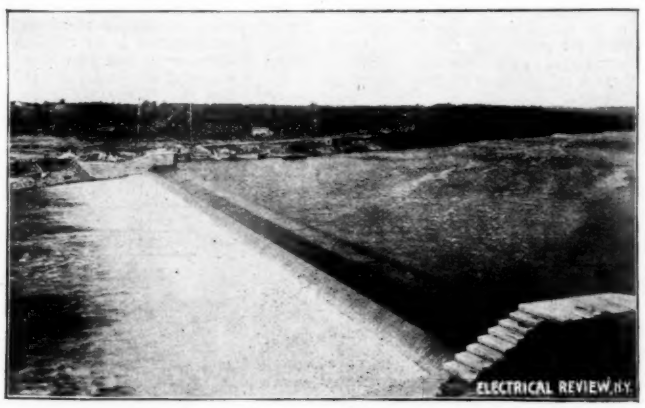


FIG. 2.—DAM 500 FEET LONG, AFFORDING 5,000 HORSE POWER, AT SEWALL'S FALLS, N. H.

and in 80 minutes all the machinery was in motion, with no hitch of any sort. The machines were built by the General Electric Company, at Lynn, Mass. The shafting was built by the Kidder Machine Company, after designs of Supt. Eugene F. Carpenter, who has had general supervision over the entire work from the start, two years ago. Great credit devolves upon Mr. Carpenter for the perfect manner in which the very smallest details have been worked out, and for the successful starting of the plant on its first trial. Mr. Carpenter made a record in rapid installation some time time ago in Concord, when he put in a complete arc lighting plant, from beginning to end, in just 30 days, in order to fulfil a contract made with the city. This plant consisted of 100 lights. The arc lighting from this plant, just started, will be about 300 lamps and will be run from ordinary Thomson-Houston arc dynamos. The motor service (700 horse-power) and the incandescent lighting will be run from the triphase generators. The primary voltage is to be 2,200 volts and the secondary 110.

Ultimately there will be six 250 kilowatt triphase generators installed at this station. Each is about 12 feet long and eight feet high and weighs 15 tons. A much to be desired advantage of this system is that the machines are all alike, so that any one of them may be used for any required purpose, thus doing away with so many different dynamos and the necessity of duplicating them to provide for a breakdown.

The public generally is probably not aware of the magnitude of this plant away up in New Hampshire, nor of the perfect manner of its installation due to Mr. Carpenter.

The New York Fire Department has been testing, during the past few days, a device owned by the Boston Electric Hose Signal Company, and designed to increase the efficiency of the appliances now employed in fighting fires. The apparatus consists of a bell on the engine, with a battery. Two wires run the length of the hose and are ingeniously adjusted so that when the several sections of hose are united by the metallic couplings a perfect electrical connection is established between the nozzle joint and the engine. A push button is located on the nozzle, and a slight pressure upon this rings the bell and conveys any information desired to the engineer in charge by means of an understood code of signals.

POLYPHASE TRANSMISSION.

FULL TEXT OF A MOST INTERESTING AND INSTRUCTIVE PAPER, WITH ITS DISCUSSION, READ BEFORE THE NATIONAL ELECTRIC LIGHT ASSOCIATION, WASHINGTON, 1894, BY CHARLES F. SCOTT.

ALTERNATING CURRENT PROBLEMS.

When alternating current was introduced for lighting it presented many new problems to the electrical engineer. Numerous difficulties and dangers were predicted by the theorist, but in ordinary service most of these have fortunately lain dormant. These difficulties are apt to appear, however, when alternating current work is attempted on a large scale. The introduction of large units, heavier currents, higher potentials or power service are apt to increase the effects of self-induction and capacity so that they will now demand careful consideration. The impetus which electrical engineering is receiving from the introduction of the polyphase system, which brings with it large units and long distances, naturally directs attention to the general problem of alternating current transmission and distribution.

A complete and exhaustive solution of this problem is by no means a simple one, and the attempted solutions generally lead to formulas and diagrams which are possibly even more perplexing than the phenomena. If even the electrician who devotes all his energy to new problems can scarcely keep abreast of the times, it is not surprising that the practical engineer and station manager become perplexed and confounded at the apparently erratic phenomena observed in practice or described in print. Theoretical articles appear on variation in wave form, harmonies, so-called Ferranti effects, increased resistance in conductors with alternating currents, hysteresis, peculiar magnetic circuits, resonance, oscillations, lag, capacity, self-induction. Many of these articles, although evidently intended to be of service in engineering, show apparently no adequate appreciation of the practical bearing and relation of the subjects treated, consequently the average engineer becomes bewildered and perplexed, and concludes that theoretical explanations are of little value to the practical man. There are, however, many points of great practical importance which admit of fairly simple statement and explanation. The particular element to be considered in the present paper is the transmission circuit.

EXPERIMENTS ILLUSTRATING SELF-INDUCTION.

One of the fundamental characteristics of alternating current working is self-induction. The effect of self-induction is most readily shown by a simple experiment. A wire having a resistance of 10 ohms may be wound in a coil. Ten volts will send a continuous current of one ampere through this coil. An alternating current of a certain frequency will require 50 volts for producing one ampere through the same wire (Fig. 1 *a*). In the diagrams the numbers above the circuit are for continuous current, and those below are for alternating current. If a one ampere 50 volt lamp be placed in series with the coil and a current of one ampere be passed through the two in series the electro-motive force required for continuous current is 10 volts on the coil and 50

volts on the lamp, or 60 volts across the circuit, and the electro-motive force required for alternating current is 50 volts across the coil and 50 volts across the lamp, which gives, not 100 volts, but 78 volts, measured across the two in series (Fig. 2). If two lamps be placed in multiple and connected in series with the coil, two amperes will require for continuous current 20 volts on the coil and 50 volts on the lamps, or 70 volts across the circuit. For alternating current the electro-motive force on the coil

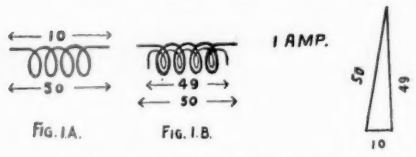


FIG. 1.A. FIG. 1.B.

is 100 volts and on the lamps 50 volts, and on the circuit across the two in series the electro-motive force is 120 volts (Fig. 3).

The two lamps which are in multiple may be placed in series with a second coil so proportioned that an electro-motive force of 50 volts will send one ampere alternating current through the combination, and a continuous current of one ampere would be caused by 35 volts. This combination may be treated as a unit, and may be used to

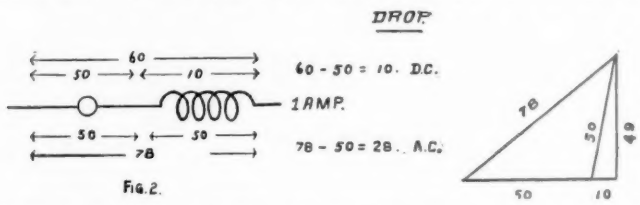


FIG. 2.

replace the single lamp in the above test (Fig. 2). If this combination be placed in series with the first coil, the electro-motive force required for sending the continuous current through the circuit will be 10 volts on the coil and 45 volts on the circuit. If the alternating current of one ampere be sent through the circuit 50 volts will be required across the combination and 50 volts across the coil, the same as with the single lamp, but the electro-motive force across the

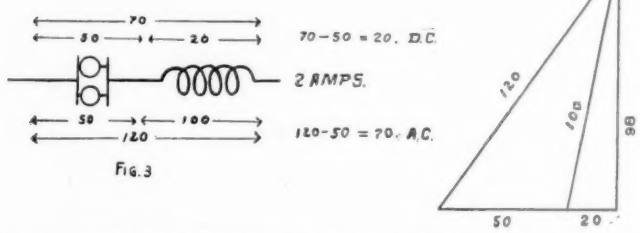


FIG. 3

circuit is no longer 78 volts, but has increased to 95 volts (Fig. 4).

The important facts to be noted in these experiments are (1) that the sum of the alternating electro-motive forces on the elements in series is greater than that required on the terminals; (2) that the alternating electro-motive force for supplying the lamps in series with a coil is greater than the continuous electro-motive force; and (3) that the difference between the two becomes greater as the number of lamps is increased (Figs. 2 and 3). It is also to be noted (4) that if the same alternating current be supplied through a coil, first to a lamp alone and then to a combination including lamps and a coil, a higher electro-motive force is required when the combination is used (Figs. 2 and 4).

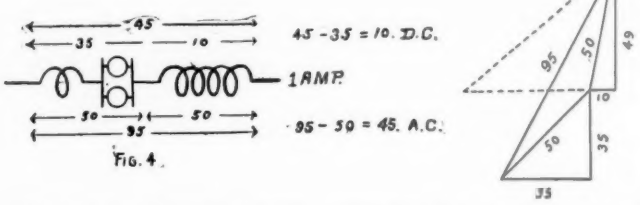


FIG. 4.

These relations, which seem rather perplexing, may be illustrated in a very simple way by diagrams. In the case of the coil alone, in which 50 volts are required for producing one ampere alternating current and 10 volts for one ampere continuous current, these two electro-motive forces may be represented by the hypothenuse and one side of the familiar right angle triangle. The remaining side represents the counter electro-motive force in the coil. If a second wire had been wound in this coil in parallel with the first it would be found that when one ampere is passing there is an electro-motive force on the terminals of the second or idle wire of 40 volts (Fig. 1 *b*). This electro-motive force is caused by the field produced by the alternating current. An equal electro-motive force is, of course, induced in the wire carrying the current, as the two wires occupy virtually the same position. This counter electro-motive force is seen to correspond with the third side of the triangle. Suitable measurements would show that this counter electro-motive force occurs later than the current through the coil and that its maximum value occurs when the current is passing through its zero. This relation is shown in the diagram by the 90 degree relation of the lines representing counter electro-motive force and the volts required for sending continuous current through the line.

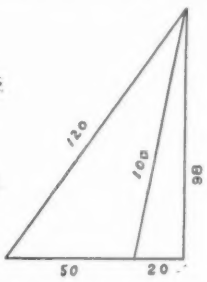
SELF-INDUCTION IN CIRCUITS.

An ordinary circuit may be considered as a choke coil in which there is a single turn. The action in this case is very similar to that illustrated above with a coil of many turns. The effect of self-induction in a circuit may be most readily understood by some simple diagrams. A current of, say, five amperes is delivered at 100 volts over a circuit of one-fifth of an ohm resistance. The self-induction of the circuit is such that five amperes generate a counter electro-motive force of 10 volts. Both continuous and alternating currents are used, and the generator electro-motive force is in each case adjusted to give 100 volts at the load.

The load consists, first, of five incandescent lamps. A coil of high self-induction is then added, which increases the current from 5 to 5.1 amperes. One of the lamps is then cut out and replaced by coils of such a self-induction as to give a total of five amperes. Then all of the lamps are cut out and coils substituted of such a number as to take five amperes at 100 volts. The electro-motive force required on the generator and the resulting drop, or difference of electro-motive force at the dynamo and at the load, are given in the diagrams and in the following table:

	Continuous Current.	Alternating Current.			
	Fig. 5.	Fig. 6.	Fig. 7.	Fig. 8.	Fig. 9.
Current in line...	5	5	5.1	5	5
Current in lamps	5	5	5	4	0
Current in coils	0	0	1	3	5
Electro-motive force on load	100	100	100	100	100
Electro-motive force on line	1	10	10	10	10
Electro-motive force on generator	101	101.5	102.5	106	110
Drop—total	1	1.5	2.5	6	10

It is to be noted that with exactly the same circuit for supplying five lamps with the same amperes at the same electro-motive force, there is an increase of drop between



generator and load when continuous current is replaced by alternating current. This drop is much less than the volts required for sending the alternating current through the line, and it, moreover, increases enormously as the load becomes even slightly inductive. Thus, when the current is increased only two per cent. (from 5 to 5.1 amperes, Figs. 6 and 7) by the addition of inductive load to the lamp load, the increase of drop, due to self-induction, is increased from one-half per cent. to one and one-half per cent., or an increase of threefold. When the load consists of four lamps and coils are added in multiple to take a total of five amperes, or the same as that taken by the five lamps from the generator, the drop is four times the drop when five lamps alone are in circuit. If the remaining four lamps be replaced by coils, the drop does not increase in proportion, but from six to only 10 per cent. The effect, therefore, of a slight self-induction in the load

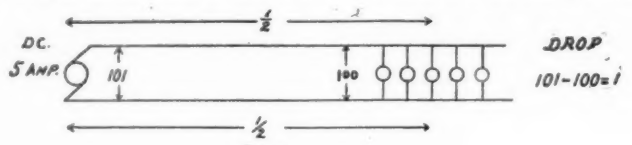


FIG. 5.

causes a much greater proportional drop than the presence of a large self-induction. A counter electro-motive force of 10 per cent. is not at all likely to occur in a 100 volt line carrying small current. The figures given, however, serve as an illustration of the percentage variations, which are liable to occur in other parts of the system.

DROP IN CONTINUOUS AND ALTERNATING CIRCUITS.

The word "drop" in continuous current calculations has a perfectly well-defined meaning. In the case of the five lamps which take five amperes at 100 volts through a circuit of one-fifth of an ohm as illustrated in Fig. 5, the drop is (1) the difference

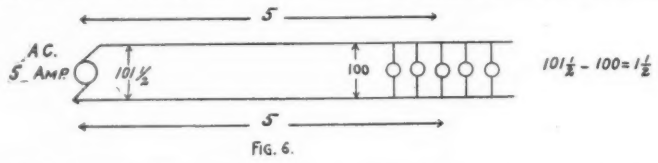


FIG. 6.

between the electro-motive force at the generator and at the lamps, or one volt, which is one per cent.; (2) it is the electro-motive force required for sending the current through the line. This is equal to the current multiplied by the resistance, and is the electro-motive force which would be required for sending the current through the line if

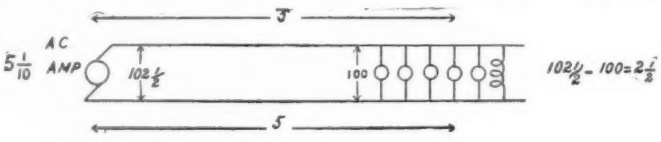


FIG. 7.

the load be short circuited; (3) a drop of one per cent. means also that the energy lost in the line is one per cent. of that delivered by the generator; (4) a loss of one per cent. in the line also signifies that the energy delivered is one per cent. less than that supplied by the generator.

In alternating current work the same uniformity does not exist; for example, in the experiments with the same five lamps and the same line, (1) the generator pressure was $101\frac{1}{2}$ volts, or one-half per cent. higher than that of the lamps; (2) the electro-motive force required for sending a current through a line short-circuited is 10 volts, or 10 per cent.; (3) the energy lost in wires is C^2R, or five watts, which is one per cent. of the energy when five lamps are supplied. If four lamps and low resistance coils are connected to the circuit, the energy delivered is, say, 400 watts and the loss is one and one-fourth per cent.; (4) if the coils alone are supplied and their combined resistance is equal to that of the circuit, or one-fifth of an ohm, then the losses in load and line are equal and the actual line loss is 50 per cent. The apparent energy at the generator is 550 watts (110 volts and five amperes), and the apparent energy delivered is 500 watts (100 volts and five amperes), so that the apparent line loss is nine per cent.

It is, therefore, evident that the several elements commonly referred to as drop or per cent. loss with continuous current are so modified when alternating current is used, that it is possible for no two of them to have the same value. Moreover, with alternating current none of these elements may have the same per cent. value as that for continuous current on the same circuit.

LOSS AND REGULATION.

The two vital factors in the line are loss and regulation. The losses are C^2R and should be expressed in watts or horse-power, or as a per cent. of the energy delivered to

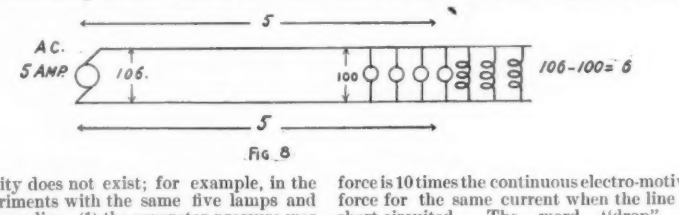


FIG. 8

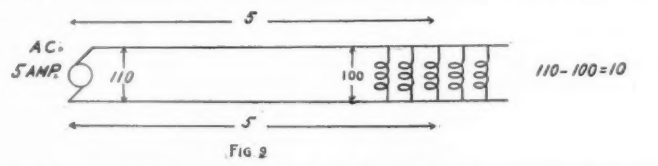


FIG. 9

the line. The practical point in regulation is the difference in electro-motive force at the generator and at the load. When these two factors are known it is generally immaterial what electro-motive force might be required for sending current through a short-circuited line. The word "drop" is applied to the difference in electro-motive force between the generator and the load. The regulation is generally expressed in per cent. of generator electro-motive force, but in this paper the electro-motive force at the load will be considered 100 per cent. as this is the element to be kept constant while the electro-motive force of the generator is variable, depending upon the load and other elements.

The regulation, or drop, in the alternating current circuit is dependent largely upon the counter electro-motive force of the line. The factors which practically determine the counter electro-motive force of the line are size of wire, distance between wires, length of circuits, frequency and current. Mr. A. E. Kennelly has given very complete curves (American Institute of Electrical Engineers, April, 1893) for determining the impedance of pole lines. The impedance factors given may be used for finding the current through a given line which is short-circuited at one end when the electro-motive force and frequency are known. The impedance factor of the line for supplying five lamps described above is 10, as the alternating electro-motive force is 10 times the continuous electro-motive force for the same current when the line is short-circuited. The word "drop" is applied in Mr. Kennelly's article to the volts required for overcoming impedance in a circuit, and the impression that this is the same as the drop in continuous current circuits was not corrected in the paper, nor was this most practical point raised in the discussion. The relation between impedance and loss was, however, demonstrated mathematically in a communication after the meeting. The figures given in connection with the foregoing diagrams show very clearly that a circuit having the same impedance may have a drop between the generator and the load of from one and one-half to 10 per cent, depending upon the character of the load. Impedance, therefore, does not determine regulation.

CALCULATION OF DROP IN ALTERNATING CIRCUITS.

The regulation of a circuit is, in general, determined by two elements—the counter electro-motive force of the circuit and the self-induction of the load. The counter electro-motive force of a line depends upon the size of wire, the distance between wires,

and increases directly as the length of the circuit, the current and the alternations. The counter electro-motive force of a line has been calculated for a number of cases which are likely to occur in practice, and the results are given in Fig. 10. The drop, or difference of potential between generator terminals and the load terminals, due to the counter electro-motive force of the line, depends, as has been shown, upon the self-induction of the load. The latter is best expressed by a power factor, or a factor by which the product of the amperes and volts giving the apparent energy must be multiplied to give the true power in watts. The power factor for incandescent lamps is 1.00, or the apparent energy is equal to the

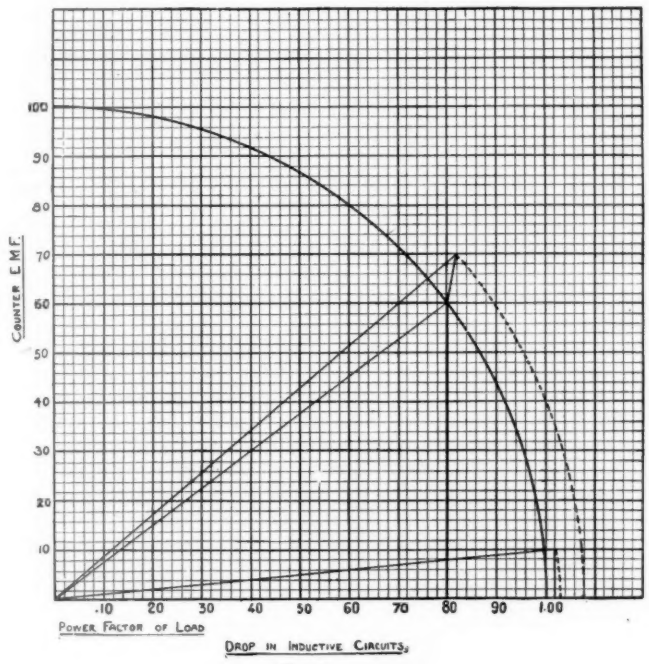


FIG. 10.

true energy. The power factor for converters loaded with incandescent lamps is usually over .99. The factor for unloaded converters varies from .50 to .80, and in open magnetic circuit converters, notably the "hedge hog," the factor may be as low as .05. The drop due to self-induction on the line (which, plus the ohmic drop will give approximately the total drop), corresponding to various power factors of the load, is given in Figs. 12 A and 12 B. The curves show that if the power factor be 100 per cent., as it is with incandescent lamps, the inductive drops for various counter or inductive electro-motive forces are .02 per cent. for two per cent.; .08 per cent. for four per cent.; .18 per cent. for six per cent.; .32 per cent. for 8 per cent.; .5 per cent. for 10 per cent.; 1.2 per cent. for 15 per cent.; and 2.0 per cent. for 20 per cent. The curves show that the drop increases very rapidly at first if the power factor

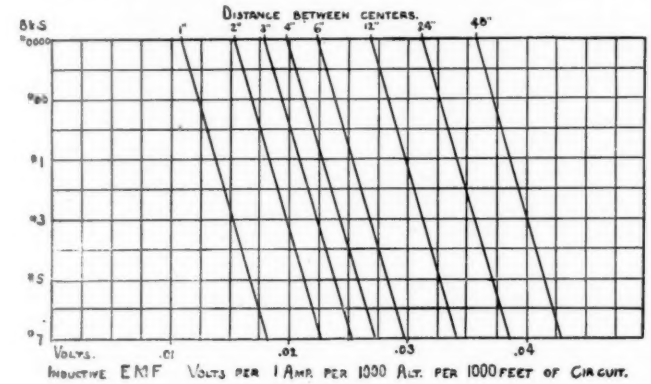


FIG. 11.

becomes less. These relations may be elegantly determined by a simple diagram on section paper ruled in tenths. Draw an arc through a quadrant with a radius of 100. At a distance from the center on the horizontal, equal to the power factor of the load, erect a perpendicular and extend it to the arc. This line represents the counter electro-motive force of the load, and its value read directly on the scale gives the counter electro-motive force in per cent. of the electro-motive force upon the load. From the intersection of the arc draw a horizontal line outside the circle, equal on the scale divisions to the per cent. in terms of the electro-motive force on the load, which would be required for sending the normal amperes continuous current through

transformers, secondary wiring, and sometimes in the load. In each case the effect of the self-induction upon regulation depends largely upon the self-induction of the total load which it supplies. Thus, the regulation of a generator depends upon the total self-induction of the line, transformers and load. Again, the regulation of a line supplying converters depends both upon the self-induction of the converters as well as that of the useful load. The same analysis, diagrams and tables, which have been used above in connection with the line, will apply to the transformers and approximately to the regulation of the generator.

An ordinary transformer has a primary self-induction and a secondary self-induction and a mutual induction which becomes a ready source of a very complicated and perplexing analysis when the complete action is described in theoretical terms. Practically, however, the action of the self-induction in the transformer may be expressed in a very simple way, and it is readily seen that this self-induction has a very important bearing upon the regulation of the transformer. The regulation of the transformer is very similar to that of a line, as explained above. If the secondary coil be short-circuited the electro-motive force on the primary may be adjusted so that the normal full load current passes through the apparatus. This electro-motive force corresponds very closely to the electro-motive force required for sending current through a short-circuited line, and, in ordinary transformers, is, practically, equal to the counter electro-motive force, and may be considered equal to it.

A transformer may be taken for experiment, in which the electro-motive forces are

the line resistance. From the end of this horizontal line draw an upward vertical equal to the counter electro-motive force of the line expressed in per cent. of the electro-motive force on the load. A line from the center to the upper end of this vertical represents in direction and magnitude the electro-motive force which must be impressed on the circuit. If from the same center an arc be drawn through this point to the base, the scale divisions on the base between the two arcs measures the total drop caused by the line in terms of the electro-motive force on the load.

SELF-INDUCTION IN TRANSFORMERS, ETC.

Self-induction exists in line, generators, in pressure at the secondary terminals between no load and full load will be one per cent. if the self-induction be negligible. If, however, there is a self-induction, so that 100 volts, or ten per cent., is required for sending the normal current through the primary when the secondary is short-circuited, then the drop in pressure is, in general, greater than one per cent., depending principally upon the character of the load. The load may be non-inductive, as lamps, or it may be more or less inductive. The experiments described above, in which a line had the same per cent. ohmic and inductive characteristics as the converter just described, apply to the converter as well as to the line. The drop on such a converter, therefore, may vary from one and one-half to 10 per cent. when delivering its rated current. Arc lamps or fan motors will produce a very much greater drop than incandescent lamps. The power factor of an alternating current arc lamp varies considerably, but in a number of cases has been found between 85 and 90 per cent. The drop when incandescent lamps are replaced by arc lamps on the transformer just described, increases from about one and one-half to five or six per cent.

A secondary line, if it carry a large current, may have a counter electro-motive force of several volts. This may not be enough to increase appreciably the drop in the line between the transformer terminals and incandescent lamps. But the transformer, however, delivers current to the secondary circuit and to the lamps, so that the regulation of the transformer may be effected by the self-induction of the secondary circuit. Cases have occurred in which transformers of a very old type, possessing high self-induction, were supplying very large secondary currents, and the resulting drop in the transformers was increased several per cent. For example, a circuit of No. 0000 B. & S. wire, supplying 100 amperes to 50 volt lamps at a distance of 100 feet, has an ohmic drop of two per cent. The constant for counter electro-motive force of this circuit, if the wires be six inches apart, is .022. The volts at 16,000 alternations are .022x100x.1x16=3.52, or seven per cent. of fifty volts. The inductive drop in the line corresponding to seven per cent. is .25 per cent. The power factor of the aggregate service of the transformer is the second side of a right angle triangle, of which seven is one side and 100 is the hypothenuse. This is 99.7, which is the power factor of the total load on the transformer. If the self-induction of the converter be 10 per cent., the inductive drop is 1.2 per cent.; if 20 per cent., the inductive drop is 3.4 per cent., and if 30 per cent., the inductive drop is seven per cent. The aggregate drop in the converter and secondary circuit in the latter case would be, say, two per cent. for ohmic drop in transformer, two per cent. ohmic drop in line, seven per cent. inductive drop in transformer and .25 per cent. inductive drop in line, or a total of 11.25 per cent. The necessary ohmic drop is four per cent., and the inductive drop resulting from self-induction in transformer and line is, therefore, 7.25 per cent. If the number of alternations be reduced to 7,200, the inductive drop would be reduced from 7.25 per cent. to one and one-half per cent.

ORDINARY TESTS UPON TRANSFORMERS.

The practical bearing of the self-induction of a transformer upon its regulation, and

1,000 volts and 100 volts. If five volts, or one-half per cent., is required for sending through the primary a continuous current equal to the normal full load current of the transformer, and if a similar electro-motive force in the secondary is one-half a volt, or one-half per cent., then the ohmic loss in the transformer is one per cent., and the drop

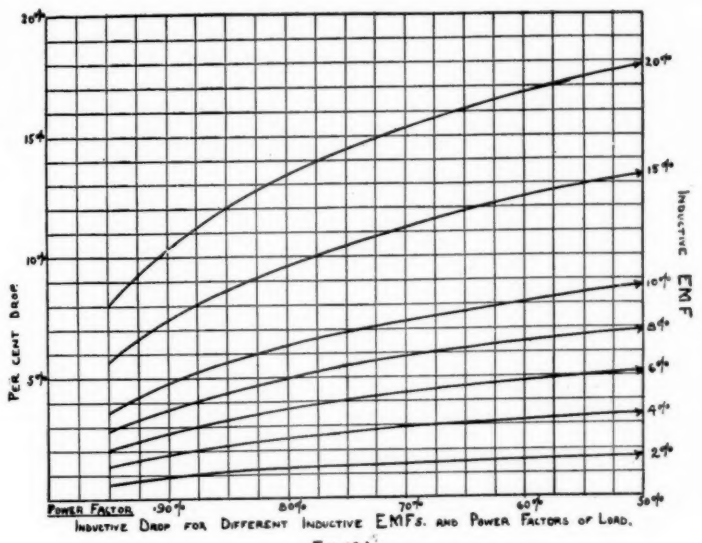


FIG. 12 A.

of the current wave, and measurements upon the iron losses are attempted within very close limits of error. Their measurements upon the regulation of the same transformer, however, vary from two per cent. to 2.4 per cent., or one measurement is one-fifth greater than the other. The presence of slight induction in the secondary load would have caused a very considerable increase, and it is probable that the difference in the measurements made were due to difference in the self-induction in the instruments used or in the load at the time the tests were made. No note is made of the effect of the self-induction of the load upon regulation, although regulation is one of the most vital points in the practical use of transformers. Even the temperature at which the drop was measured is not stated, although the resistance of a transformer, when continuously working, may be 20 per cent. greater than when cold. The elements of practical importance in a transformer are (1) the iron loss, in respect to the efficiency; (2) the regulation, in respect to the satisfaction of service; and (3) the temperature to which the insulation is subjected, as affecting the life of the transformer. In the ordinary tests by

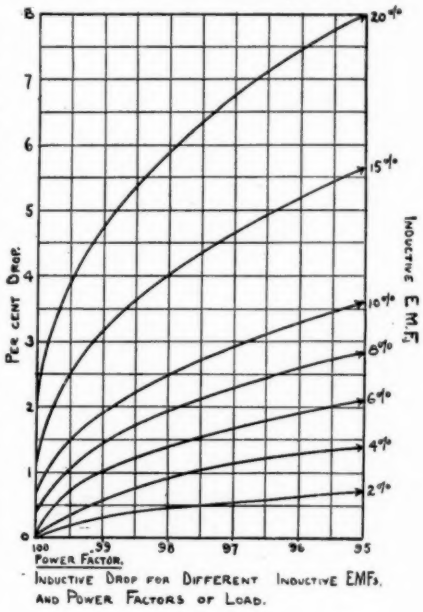


FIG 12 B

theoretical men, the iron loss is measured to a very high degree of refinement, although the iron loss in transformers is the one thing which cannot be controlled, and is certain to vary 10 or 15 per cent. in commercial manufacture of transformers of the same size. The wave of electro-motive force on different dynamos, or the difference in form under different conditions of load on a circuit, may make the loss under different commercial conditions vary several per cent. This renders more refined measurements of no practical use unless the conditions are stated. The temperature of the iron also affects the loss. The full load

(Continued on page 130.)

Notes of a Trip to the United States and to Chicago—1893.

READ BEFORE THE INSTITUTION OF ELECTRICAL ENGINEERS, LONDON, JANUARY 25, 1894, BY W. H. PREECE, C.B., F.R.S., PAST PRESIDENT.

(*Continued from page 95.*)

Chicago.

I have given the number of exchanges and subscribers in Chicago. To provide for this service there are:

Miles of conduit	48.02
Miles of duct, or channel	433.24
Miles of cable, underground	106.96
Miles of wire, underground	17,995.53
Number of manholes	888.0
Miles of cable, aerial	65.97
Miles of wire in aerial cables	5,184.70
Total miles of wire in cables	23,180.23
Total miles of wire on poles	7,958.0

Switchboards and Indicators.

Great improvements in working have been made in consequence of the introduction of metallic circuits. Visual signals, like those employed by the post office department, are coming in. Dirt in the gear was a great source of trouble. False busy signals were frequently received. Now a third wire and an automatic restoring indicator has made the busy test reliable. The visual signals on trunk wires are assimilating the American working to our post office system.

Disturbances.

The disturbances in telephone circuits created by the extension of electric railways have been severely felt in many parts of the United States. We have experienced the same in London, Liverpool, Leeds and Blackpool. But owing to the prompt action taken by the telephone and railway companies, especially in Boston, the area of disturbance has been much reduced, and the influence of electric railways on telephones has ceased to be a trouble. Of course this result is very much favored by the rapid introduction of metallic circuits into cities; but it has also been favored by the prompt action of the railway companies themselves. They did all that they were asked to do, and that at once. In all cases the negative pole of the dynamo at the generating station is put to earth, and the return conductors have been enlarged. Extra copper wires have been buried between the rails, and heavier conductors have been put upon the poles. The return conductor is the largest size copper wire made, viz., No. 0. The rails have been bonded together and to this return conductor; and in Boston the rails are welded electrically, which is very effective. I was, unfortunately, unable to see this electric welding in operation, for the transformer had broken down, and was in the shops under repair. I saw the whole apparatus, however. A special car is used for the plant, and the system adopted is extremely satisfactory.

The electrolytic action of these disturbing currents has been noticed not only as affecting gas and water pipes, but also the lead coating of the telephone companies' cables. I have seen several specimens of lead pipes much pitted. I have reason to believe that the remedies adopted to cure disturbance will also put a stop to what might have become an element of great danger to underground cables.

Lightning Protection.

A very efficient system of lightning protection has been introduced upon the telephone system, not so much to protect the system from the effects of lightning as from the effects of those powerful stray currents that enter a telephone circuit when accidental contacts occur between it and electric light and electric railway conductors. Such contacts have been frequent, owing to the prevalence of overhead systems, but they are diminishing now that conductors are placed underground. They have resulted in numerous accidents, and several telegraph and telephone offices have been set on fire and the apparatus destroyed. Every telephone circuit is now protected by a fuse, or cut-out—a fine wire of great resistance, which melts if traversed by a powerful current; also by an air space protector, on the same principle as the lightning arresters we use, but having carbon plates instead of brass plates; and, finally, by a small heat coil, which puts the current to earth in a very ingenious way when the stray currents exceed a certain strength. These three guards have been found quite effective. No accident has occurred where they have been used.

Rates.

The rates or rentals demanded from the various subscribers differ very much in the States. At Buffalo they charge a toll rate on each talk; they do not demand an annual rental; they simply demand a minimum amount of business per annum. This rate in Buffalo is 10 cents for five minutes' talk, and they have adopted a system of charging one-fifth of this rate for each extra minute beyond the five. The rate in San Francisco is a small annual rental for each installation, and 5 cents for each talk. A somewhat similar plan is in use at Milwaukee. But, with these three exceptions, the toll system has not found favor in the States, and at every other exchange an annual rental is demanded.

The American Bell Telephone Company is now considering the advisability of limiting the time for talks to three minutes instead of five, of reducing the minimum toll in proportion, of making additional charges for each minute *pro rata*, and of considering a fraction of three minutes as equivalent to the whole time.

I give below, in tabular form, the rentals charged in 25 of the chief cities of the States:—

STANDARD YEARLY RATES FOR SUBSCRIBERS.

	Business.		Residence.	
	Metallic Circuit.	Single Wires.	Metallic Circuit.	Single Wires.
New York	$240	$150	$180	$100
Chicago	175	125	135	100
Philadelphia	160	120	130	100
Brooklyn	150	.....	100	.....
St. Louis	.....	$100 120	.....	$60.80 100
Boston	$156 160	120	$110 134	96
Baltimore	120 160	78	90 160	78
Cincinnati and Covington	125	100	100	72
San Francisco	*72 90	*60	72 90	60
Cleveland	120	72	100	60
Buffalo	† Toll	.....	Toll	
New Orleans	.....	96	.....	62.50
Pittsburgh	126	84	112.50	75
Washington	120 160	100	90 160	72
Detroit	.....	72	.....	50
Milwaukee	‡80 90	60	70 80	50
Newark	150	.....	100	
Minneapolis	120	72	100	60
Jersey City	150	.....	100	
Louisville	.....	72	.....	60
Kansas City	.....	72	.....	60
Omaha	.....	60	.....	60
St. Paul	120	72	100	60
Providence	120	60	100	48

The rates vary, and are, as will have been seen, very high; but although the enterprise is in the hands of private companies, it must be noted that they have great difficulties to contend with. In a place like New York the rents and the cost of buildings is excessive. In one small exchange they pay no less than $7,000 a year rental for one floor. Taxes everywhere are enormous. Not only are they taxed by the State, but they are taxed by the municipalities. Way-leaves are excessive. In New York alone they have to pay to the company controlling the underground conduits no less than $250,000 per annum for duct rentals—$251 per renter for way-leave alone. The distances, too, that they have to carry their underground system in New York, in Philadelphia, and in other places are very considerable. They have been forced by municipal action to go underground. In the face of these restrictions no comparison between rentals in New York and those paid in this country can be made. The amount of the average rental in London scarcely exceeds £15 per annum. The average amount of rental throughout the country on our post office system is £9 10s., but in New York subscribers have to pay up to £50 per annum.

*Also "toll" of five cents per conversation.
†Installation charge, $70 for first 500 messages.
‡Rates cover installation and yearly business of 1,000 messages; $10 is charged for each additional 500 messages.
NOTE.—Where two rates are given in the same column against an exchange they represent different kinds of instruments furnished. In many cases single-wire rates are no longer quoted for new subscribers.

(To be continued.)

Government Insulated Wire Tests.

Probably the most rigid tests of insulated wire made are those of the government electricians at the Brooklyn Navy Yard. All wire and cable for use on government vessels must first be immersed in salt water at a temperature of 72 degrees Fahrenheit for 48 hours, and show an insulation resistance of not less than 1,000 megohms per mile. It is then taken out of the water and placed in an oven, the temperature of which is raised to 212 degrees Fahrenheit, and there it must remain one week. From this oven it is again immersed in salt water, at the same temperature as at first, and if the insulation shows not less than 1,000 megohms, it is passed. The great number of war vessels equipped with wire and cables made by the Safety Insulated Wire and Cable Company, of New York, is pretty good evidence of the quality of their products.

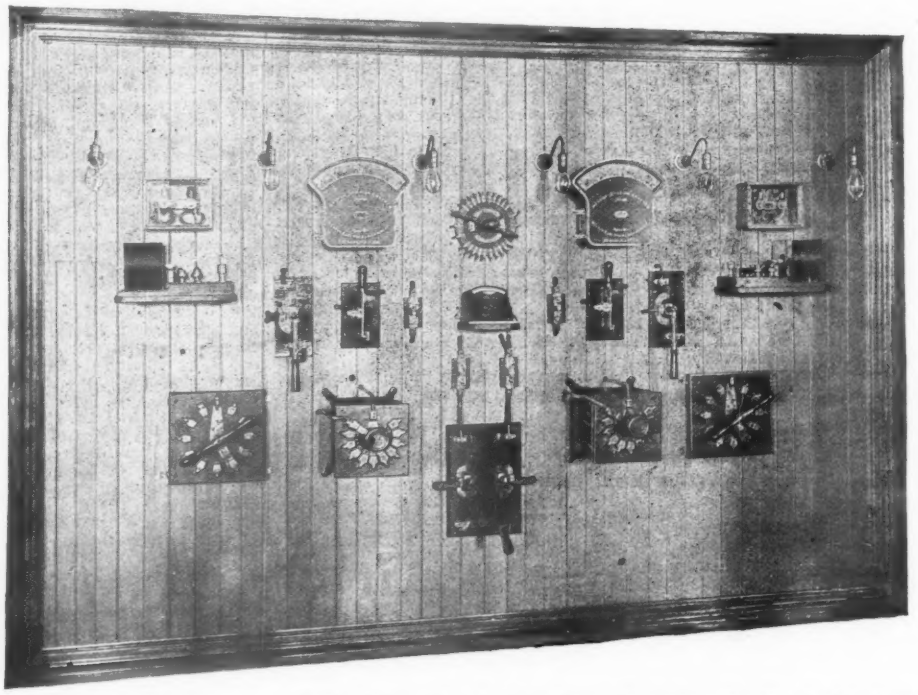


FIG. 1.—STORAGE BATTERY SWITCHBOARD, GERMANTOWN, PA., ELECTRIC LIGHT COMPANY.—(See Mr. Appleton's Discussion Before the National Electric Light Association.)

Commercial Cable Company.

At the annual meeting of the Commercial Cable Company, held in New York on March 5, the gross earnings for 1893 were shown to be $1,842,346; expenses, $784,600; balance of $1,057,746, a decrease of net earnings, as compared with 1892, of $41,840. The usual quarterly dividends of one and three-quarter per cent. have been paid. The company has paid off $600,000 debenture bonds, and made provision for redeeming the $400,000 outstanding. A third cable will be completed next July.

The New Metropolitan Club Building.

Messrs. McKim, Mead & White, the architects of the Metropolitan Club House, that marble palace at the corner of Sixtieth street and Fifth avenue, in this city, extended an invitation to their friends to inspect the handsome structure on Monday, February 26. After two years of laborious work this structure, nearly the handsomest of its kind in the country, was turned over to the members of the club on March 1st.

The architects have not been unaided in their work, and foremost decorators and designers, both in the artistic as well as the practical parts, have put in their best workmen to do the best possible work.

The Waddell-Entz Company furnished the generators, which are direct connected to straight-line engines. There are three dynamos in all. Two of them are of the 50 kilowatt type, giving, as stated, 120 volts and 450 amperes. The smaller dynamo is of the 30 kilowatt type. The engines were made by the Ball & Wood Company, and are remarkably noiseless in their running. The entire combination in fact makes so little jar or noise that, unless one is in the same room with them, there is nothing otherwise which would betoken their presence. The switchboard and wiring was installed by the Western Electric Company.

The boilers, three in number, were made by Baker, Smith & Co., and, running at 80 pounds, are rated at 100 horse-power.

The plainer fixtures were manufactured by the Archer-Pancost company, but it must be stated that their designs are remarkably like some recently imported from France. The workmanship is not quite as solid as that of our French brethren, but from the outward appearance the effect is nearly as satisfactory. The French fixtures, which are placed among the handsomest of the decorations, give evidences of elegance combined with great durability. But the mural decorations cannot be seen without producing an excellent idea of the supremacy of the French in their capacity as decorators. The celebrated house of Cuel had this in charge, and for 16 months 150 artists and workmen were busy painting and otherwise decorating. Such another magnificent *chef-d'œuvre* cannot be seen in this country. The stucco figures are in medium high bas relief, and are, every one of them, works of art. M. Cuel has by this work obtained a reputation which is one to be proud of. M. Graux has had much of this work in charge, and considerable credit is due him.

The style of the American fixtures above the parlor floor is rather severely plain.

An order or kitchen service system is furnished with air by a blower run by a Waddell-Entz motor, and upstairs in the laundry department another similar motor operates the washing machinery.

Throughout the entire house everything is built for good, solid comfort. The entire plant of 2,100 lights is entirely adequate for the needs of all the occupants.

The Chloride Accumulator Plant at Germantown, Pa.

MR. J. APPLETON'S DISCUSSION BEFORE THE WASHINGTON MEETING OF THE NATIONAL ELECTRIC LIGHT ASSOCIATION, FEBRUARY 28, MARCH 1 AND 2, 1894.

Mr. President and Gentlemen of the Convention: The previous speakers have gone over the general ground concerning the use of storage batteries in central stations and have said what might be done. I would like to draw your attention to something that has been done in this country and which speaks for itself. I refer to the storage battery plant which my company, the Electric Storage Battery Company, who manufacture the chloride accumulator, have recently installed for the Germantown Electric Light Company.

The Germantown Electric Light Company have the distinction of being the first electric lighting company to use a storage battery equipment of American manufacture and design.

The illustrated sheets which you will find in the seats gives a general idea of the battery plant at Germantown, but I believe it is of sufficient interest to this Convention to look more fully into the matter, and show how the adoption of this battery has changed the state of affairs in this station.

The Germantown company had a day load of incandescent lamps and motors on the three-wire system, which was very unprofitable, and about 15 months ago they decided to try the use of a storage battery to see if the day load could not be made profitable instead of a dead loss.

A small battery was put in sufficient to carry the day load; its capacity was 800 ampere hours, with a normal rate of discharge of 80 amperes.

The machinery was then shut down from daylight till dusk, the battery taking care of the day load.

This being an experiment to ascertain the true facts about the working and value of a storage battery for central station purposes, very careful figures were kept, and the result of the first year's working was eminently successful, and resulted in a large saving.

By the kindness of Mr. Allen, the superintendent of the station, I am enabled to give you the figures, which are as follows: Saving on the one year's running in labor, coal, water, oil, waste, etc., not counting the decreased depreciation of machinery due to shutting down from daylight to dusk, $25. Besides this there was a great advantage in being able to overhaul and examine all machinery in the daytime while everything was shut down.

This being so satisfactory, and the behavior of the battery being equally good, the Germantown company decided to put in a battery of two and one-half times this capacity, which would enable them to increase their day load and consequently increase the savings, as the cost of charging a large battery is only increased by the extra fuel used. This larger battery was installed at the beginning of this year, and is the one which I will now describe.

The battery consists of 120 cells of the chloride type G, 11 plates in each, arranged 60 on each side of the three-wire system; the capacity of each cell is 1,000 ampere hours, or 2,000 ampere hours with both sides; the normal rate of discharge is 200 amperes, maximum 400, and this can safely be increased in case of sudden demand or emergency.

The plates are protected by the improved asbestos insulation, and are contained in lead lined wood tanks. An asphalt floor well drained is provided, so that there is no trouble in handling the acid.

One special feature of these cells is the size of the plates of 15 inches by 15 inches.

Anyone who has had experience with storage batteries will appreciate this point and will readily understand how much less trouble and expense there is in the maintenance, when only 11 plates are required to give 1,000 ampere hours capacity, instead of about 80 plates as in most other types of batteries.

Plates of the chloride type can be constructed larger than this without any difficulty, and give equally good results.

This battery plant has been designed to meet all the requirements of the three wire system and to give the greatest possible flexibility. The ordinary course of working in the Germantown station is as follows:

The machinery is shut down at daylight and the battery carries the whole of the day load till dusk, when the dynamos are started again. The battery is then switched out during the hours of heavy load and started in again for charging when the load decreases.

By this means the general plant is working at an efficient load during all the hours it is running, and the extra fuel for charging the battery is hardly noticeable.

The daily routine is very simple; the discharge of the battery is noted by hourly reading, and at the end of the day the total discharge is ascertained.

A charge of about 10 per cent. in excess of the discharge is put on, and this is found to be sufficient; in some cases even less charge than this will bring the cells up to the proper electro-motive force. Just before the end of the charge, readings are taken in some of the cells with the hydrometer and voltmeter, and the condition of a cell can be accurately obtained by this means.

The maintenance of a storage battery is the point which frightens most engineers. In the old days 40, 50 and 60 per cent. efficiency was the average result, and this, I believe, is the chief reason of the slow adoption of the batteries.

Until recently sufficient attention was not paid to designing the cells for the work they had to do. Engines and dynamos are designed and installed according to the nature of the work they have to perform, and this must be done with batteries.

Given a properly designed and installed battery such as the one I have described, the maintenance and depreciation will not exceed that of the other portion of the central station plant. A storage battery does require attention, but not skilled attention; the most important thing is to go give it regular attention; do not leave it for weeks or months till some fault develops, but treat it like other machinery, overhaul it regularly and prevent the occurrence of any fault.

A method I have found to be very good in looking after large battery plants is to have voltmeter and hydrometer readings taken regularly, say once or twice a week, and every day overhaul thoroughly one cell, emptying out the acid, cleaning, if necessary, and putting everything in proper order. By doing this in the proper rotation every cell is examined, say, twice a year, yet the time required is hardly noticed, being only an hour or so every day.

In this way the efficiency of a battery can be kept high and results obtained which will put on a very different complexion in some electric light stations.

There are many stations in this country which are running the day load at a loss, or are losing business by not supplying current at all in the day. To these stations a battery plant would be invaluable and would give a very different result when the balance sheet is taken out.

In many cases it would, of course, be best to leave the battery alone, and then when the general plant is running the battery acts as a regulator, taking up any fluctuation in the load, relieving the generating plant and keeping the potential constant.

Again, in some stations the load curve takes the form of a sharp peak for a short time during the evening when most of the lights are in use. A battery will assist the dynamos during the period of maximum load, and saves the necessity of providing a generating plant which will only be used for a very short time during the 24 hours, standing idle and unprofitable the remainder.

There is another question, too, which electric light men have to face—how can we profitably reach the outlying districts over direct-current mains? Here, again, the battery plant proves valuable; small substations in the outlying districts can be built for the batteries, and those can be charged in series from, say, 400 or 500 volts, and the current distributed at the required pressure.

Every year now electric light men have to look around for a more mechanical and profitable way of carrying on their business, but let them once realize that new storage batteries can be obtained which will give good results and not prove a continual source of trouble and worry, and they have a way out of many of their troubles. A very good idea of the feeling towards storage batteries was once given by an eminent electrical engineer, but an advocate of alternating currents; he says the best thing about alternating currents is you can't put storage batteries in the circuits.

Things have now changed; figures, facts and guarantees are obtainable, which will enable electrical men to feel that storage batteries as a whole are not what they were, but when properly designed, manufactured and installed, are to be welcomed instead of shunned.

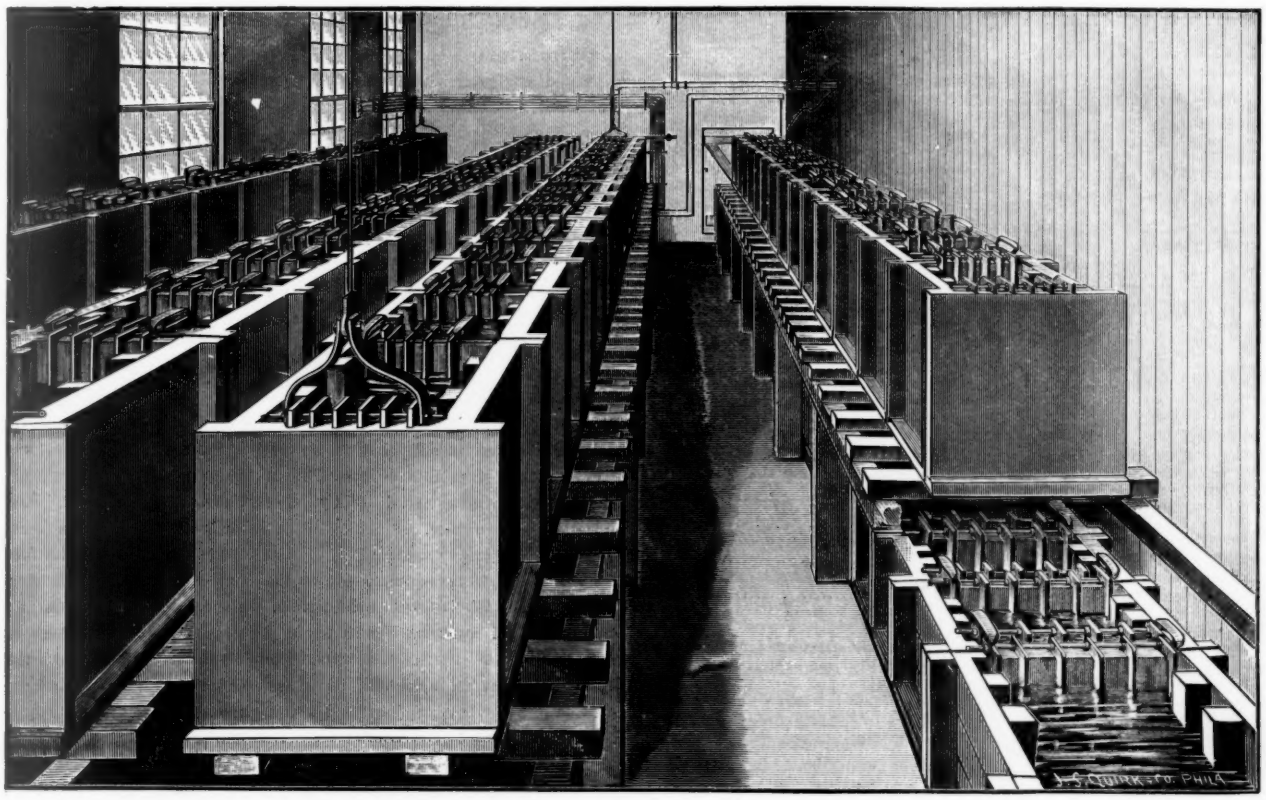


FIG. 2.—CHLORIDE ACCUMULATOR INSTALLATION, GERMANTOWN, PA., ELECTRIC LIGHT COMPANY.

LITERARY.

"Journal of the Institution of Electrical Engineers," London, for February, 1894, has been received.

We have received from the Navy Department an official catalogue of its World's Fair exhibit. The catalogue is handsomely illustrated, and was compiled by Lieut. H. C. Poundstone, U. S. N.

The annual catalogue of the Massachusetts Institute of Technology, Boston, for 1893–1894, gives the usual information regarding examinations, courses of instruction, etc., and shows that 1,157 students are enrolled for the current year.

"The *Electrician* Electrical Trades' Directory and Handbook for 1894," has been received from the publishers, the London *Electrician*. This is the twelfth year of publication of this valuable work, and each issue is an improvement over the last. The American section is fairly accurate as far as it goes.

"Telephone Lines and Their Properties," by William J. Hopkins; new edition; revised and enlarged. 12mo cloth, 272 pages; numerous illustrations. Price, $1.50. Sent post free, on receipt of price, by the ELECTRICAL REVIEW Publishing Company, 13 Park Row, New York.

The great success of the first edition of Professor Hopkins' book made another edition necessary. The author has taken this opportunity to revise and enlarge the work, making it more valuable than ever. Considering the meagreness of the literature on this subject, Professor Hopkins' book, which intelligently covers nearly the whole of the telephonic art, should be especially acceptable to the telephone worker just now when the business is progressing so rapidly in many directions. A few of the subjects treated upon in the 14 chapters of the book are city lines, underground work, long-distance lines, exchanges, switchboards, the telephone current, interference and cables. There are also two appendices, one on oscillations and the other covering Mr. J. J. Carty's experiments on induction.

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Times are getting better in electrical and general industrial circles.

Ouida, in *Othmar*, remarks: "An age which has invented the electric light has abolished solitude and respects no privacy."

Ex-President Armstrong may felicitate himself on presiding over one of the most interesting and valuable conventions ever enjoyed by the electric light men.

At last accounts the daily press had Prof. Elihu Thomson located in Providence at the head of a big manufacturing company. Our impression is that Professor Thomson is still to be found at Lynn, Mass.

To the daily press: Permit us to remind you that, notwithstanding your oft-repeated assertions that electricity is responsible for many fires, it was established at the recent Washington convention of the National Electric Light Association that in New England the fire loss from electric wires was insignificant, and that in Philadelphia during the last 10 years not one per cent. of the fires was traceable to electricity.

IS THIS THE OLDEST ENGINE?

Our Pittsburg correspondent says: There is a great curiosity here in the way of mechanical antiquity. Marshall Brothers, manufacturers of elevators, are re-equipping their shops, and, among other improvements, are installing a new engine. They have just taken out what may be said to be one of the oldest engines in the country, and, probably, it has the record for actual years of service.

It is an old fashioned slide valve, rocker motion, horizontal engine, cylinder seven inches diameter, with the extraordinary relation of a 24 inch stroke. The valve chest and steam ports are in a separate casting of very crude form. The engine worked at the leisurely rate of 50 revolutions per minute, and that may be the reason it took so many years to get tired. It was constructed and put to work in the old Marshall establishment in 1820, and has never moved from its original foundation in the 74 years of its life. It churned away steadily, doing all the work for many years, and was then supplemented by an additional cylinder, making it duplex.

The old driving pulley stayed right with the engine. It was made up of two segmental flanges spanned by wooden battens, bolted with tire bolts. The shaft is square, the fly wheel ill-shaped and wobbly, but the engine as a whole did its work—and, probably, in its long service used up more extra coal than would pay for a magnificent 500 horse-power Corliss engine to-day. Though the engine, in the three-quarters of a century, did not show any symptoms of getting tired, its monotonous subterranean life told on it so that it got *bored* repeatedly. In fact, the original seven inch cylinder is now an eight inch, and it would not stand any more cutting. I doubt if in this country there is another engine with a record of 74 years in the service of its owners.

"Permit me to congratulate you on the issue of March 7," writes a Chelsea, Mass., subscriber. "I am sure it will be fully appreciated by the electrical fraternity. The ELECTRICAL REVIEW is the best printed and most tastefully arranged journal I know, and, thank Heaven! does not overwhelm its readers with 50 additional pages of so-called advertisements, nor has it so far adopted the coupon bait, nor the inartistic attempts at picturesque drawings. The REVIEW is winning honest friends every issue." This gentleman is pleased, and we are glad to hear from him. In the mail with his letter came seven new subscribers, three renewals, one offer of 25 cents for an index of an exhausted edition, and an order from Pittsburgh for a page advertisement. These were not all the features that mail contained—but enough is given to indicate that the electrical field knows a good thing.

We are glad to learn that Mr. T. C. Martin's lecture on "The Electric Lighting of the World's Fair," illustrated with stereopticon views, which created such favorable comment at the Washington meeting of the National Electric Light Association, is to be repeated in New York city. This treat will be offered to the New York Electrical Society and its friends on Thurs. day evening, March 15, at eight o'clock, at Columbia College.

Recent experiments in Paris are reported to have successfully shown that sewage may be rendered innocuous by an electrical process which is said to be a cheap one.

THE PATENT OFFICE.

"Who will be the next Commissioner of Patents?" is a question which seems to be growing imminent and is exciting much interest. Eight months ago the ELECTRICAL REVIEW's Washington correspondence showed a most remarkable state of affairs in the Patent Office, in connection with the printing of the *Official Gazette* and the patent drawings. The extraordinary delays and the wretched character of the work were set forth and explained by the statement that Commissioner Seymour had given the printing contract to a new concern, and, in the most peremptory manner, persisted in continuing it, notwithstanding the fact that it at once became apparent that the contractor was utterly unable to properly carry on the work and in spite of almost universal protest from inventors and patent attorneys. His course in the matter was then almost inexplicable, but it is now being made clear by an investigation ordered by the United States Senate. The Senate Committee on Printing is conducting a searching inquiry into Mr. Seymour's methods, and quite enough has already been developed to show that his days of usefulness in the Patent Office are ended. The affair is apparently the result of political jobbery, and was managed by the late Assistant Secretary of State, Josiah Quincy. The testimony taken before the Senate committee is to the effect that during the last presidential campaign Quincy and a man named Horace Kenny were closely associated, under the auspices of the Democratic National Committee, in endeavors to secure the success of their party. Immediately after the inauguration of Cleveland, Quincy's labors were rewarded by appointment in the Department of State, and he, in turn, undertook to provide for Kenny by getting him a $50,000 Patent Office contract. Kenny had neither facilities for doing the work, knowledge of the business nor capital for carrying it on, but Mr. Seymour, whose appointment as commissioner was part of a political trade, was induced by the Assistant Secretary of State to favor his friend. He accepted work of the most inferior character, approved bills for it long before the required bonds were given or a contract was executed, and gave the new combination many advantages which no other contractor had ever enjoyed. It is to be hoped that the appointment of the next commissioner will free the Patent Office from the domination of politics.

Considerable space in this issue of the ELECTRICAL REVIEW is taken up by Mr. Charles F. Scott's paper on "Polyphase Transmission," read before the National Electric Light Association, at Washington. The discussion is also published in full so that our readers are now in possession of the whole subject as presented by Mr. Scott and discussed by Professor Rowland, Professor Forbes and Mr. Stillwell. The Association should deem itself fortunate in being chosen the instrument of publicity for Mr. Scott's able researches which will undoubtedly prove of increasing value to central station men, the majority of whom have heretofore regarded the polyphase current and its phenomena as something very mysterious and only to be approached by the anointed. No central station man who now has or may have anything to do with long distance transmission can afford to miss digesting thoroughly Mr. Scott's remarks.

CORRESPONDENCE.

OUR BOSTON LETTER.

The Howard Lamp.—The performances of the new incandescent arc light, manufactured by the Royal Arc Electric Company, seem to be a matter of considerable interest in this section. I have received a number of inquiries regarding them, and several have expressed a desire to see them in operation. The lamps used for street lighting in Hartford have, I am told, proved very satisfactory.

Mr. Elliott O. Johnson, for a number of years past a well-known figure in electrical circles in New England, has just acquired the New England sales agency for the Boston Incandescent Lamp Company, and will also continue, as heretofore, to represent Holmes, Booth & Haydens in this territory. Mr. Johnson's headquarters in this city are at 70 Pearl street. He reports the incandescent lamp business as rapidly improving.

The Hart & Hegeman Manufacturing Company, of Hartford, Conn., have found it necessary to greatly increase their manufacturing facilities, and with that end in view have taken new quarters at 26 High street, where they will have about five times as much space as they are now occupying. Business has been steadily increasing with the concern for some time past, and they now have more orders on hand than at any time heretofore, and more than they can handle conveniently in their present location. They expect to be in their new quarters within the next week.

The James Hunter Machine Company, of North Adams, Mass., have decided to handle their goods direct for the future, and, with that end in view, have opened an office in the Telephone Building, 125 Milk street, Boston. Mr. Richard H. Hill, general sales agent of the company, is in charge. Mr. Hill is a mechanical engineer of thorough training and wide experience, and will hereafter handle all contracts for the concern. A comprehensive catalogue has just been issued which will be found of great value to central station men and other power users, as it contains diagrams and tables relating to all classes of power transmission.

The Lynn Manufacturing Company, of this city, is another new aspirant for honors in the street railway field. This company was organized about the first of the year, and is going extensively into the manufacture of all kinds of overhead construction and supplies for electric railways. Their plant is in Lynn, Mass., and the manufacturing part of the business is under the direct supervision of Mr. A. F. Hallbauer, president of the company, who has had a large experience in this line of work. Their Sinue insulating compound, which is used exclusively in the insulation of all line material, is an article of particular merit, and is already well known for its perfect water and weather-proof qualities. The active business management of the concern is in the hands of Mr. J. C. Barr, whose four years' experience with the General Electric Company in the power and mining department have admirably fitted him for the position. A handsomely illustrated catalogue, showing a full line of their material, is now on the press and will be ready for distribution in a few days. It will be mailed on application to the main office, 620 Atlantic avenue, Boston.

Boston, March 10. H. G. T.

OUR CHICAGO LETTER.

Mr. Charles B. King, of Detroit, Mich., is interested in securing the published data on electric carriages.

Mr. J. F. Easterbrooke, western manager of J. G. White & Company, has established his headquarters at 527 The Rookery, and will be glad to meet the railway men of the West.

The Thompson Belting Company, recently located at Harvey, is now turning out a fine quality of belting. Its process is a new one and its output promises to be large in the near future.

Mr. E. C. Wall has resigned the presidency of the illuminating companies in Milwaukee. Just why, it is not known; but rumor says it is preliminary to the acceptance of an important diplomatic mission.

The Pumpelly Storage Battery Company, Chicago, is in receipt of many orders for lighting plants and is doing a most excellent business. The careful attention the company is giving to every detail of an installation is winning merited appreciation.

Mr. J. H. Rhotehamel, president of the Columbia Incandescent Lamp Company, will shortly turn over a new leaf and take unto himself one of Chicago's most charming belles. It is needless to say that the lamp business will not thrive the less because he will have won that richest of all blessings, a good wife.

Mr. Henry C. Payne has retired from the management of the Milwaukee Street Railway Company. It is understood that he has disposed of his holdings at a goodly figure. Moreover, his health demands a cessation of the unremitting toil of the last few years, and Mr. Payne realizes that he must obey nature's commands.

The Nutting Electric Manufacturing Company, of Chicago, supplied the arc lamps that illuminate the Van Buren street tunnel. In a previous letter the writer erroneously credited this installation to the Standard Electric Company, as the Standard were lighting the Washington street tunnel, and appeared to have picked up almost every order worth securing.

Chicago, March 10. F. De L.

PERSONAL.

President John I. Sabin, of the Sunset Telephone and Telegraph Company, San Francisco, was a recent Boston visitor.

Mr. Jas. I. Ayer, of Jas. I. Ayer & Company, St. Louis, was in New York last week and favored the ELECTRICAL REVIEW with a call.

Perry Yarrington, president of the Chicago Electric Company, is under indictment at Chicago for embezzling $10,000 from the gas company.

Mr. A. H. Reece, of the General Electric Company, arrived in New York last week after a three months' business trip to Jamaica, W. I.

Mr. O. T. Crosby will resign from the General Electric Company on May 1, and join the firm of J. G. White & Company, the well-known constructing engineers of New York city.

Mr. H. McK. Twombly last week denied that he intends to take the presidency of the General Electric Company, or that any of the Vanderbilt's would become directors of the company. Mr. Twombly sailed for Europe on the "New York" on March 7.

Mr. F. O. Rusling, until recently general superintendent of the Calumet Electric Street Railway Company, of Chicago, has been appointed superintendent of the Buffalo, N. Y., Street Railway, to fill the vacancy caused by the death of Mr. A. J. Porter.

Mixing Them Up.

There are some things that make an editor pull his hair, and drive the foreman of the printing house to drink. One of these occurred on the first cover of our pale green contemporary last week, in which the frisky division rule got in the wrong place and cut off the well-known officers of one prominent wire company and landed them in the midst of the card of another wire company, greatly to the astonishment of all concerned. There were in one green burial blent about as fine a crowd of electrical men as the country has produced. Each one should congratulate himself, for thereby attention was attracted at last in a manner that should prove gratifying to the most ardent advocate of advertising.

While our contemporary no doubt feels annoyed over the mistake, a mistake that every publisher, including the writer, can sympathize with, for all have been there, the companies—one in New York, one in Chicago and one in Bristol—should really feel elated over this sudden and superlative attention that has come to them when least expected.

"It is an ill will that blows no one good."

An Electrical Reunion.

In response to an invitation from Mr. Chas. Holtzer, a small but select gathering of prominent electrical men from Boston and vicinity met at Young's Hotel Saturday evening, March 10, to partake of a substantial dinner and enjoy a few hours of social intercourse.

It has long been a source of regret to many of the members of the old Boston Electric Club, that since that organization passed out of existence so few opportunities have been afforded for social intercourse and goodfellowship among the electrical fraternity of Boston, at one time, if not at present, the leading city in this country from an electrical standpoint.

It has also been the firm conviction of many that Boston could and would support an electric club, if properly organized and conducted on business principles, and it was with the view of getting to some extent an expression of opinion on the subject from a number of the most prominent members of the old organization that the call for the recent meeting was sent out.

It was extremely gratifying to Mr. Holtzer to note the hearty support accorded him from the start, in the personal attendance of nearly everyone to whom an invitation was sent. The few who were unable to be present sent messages of regret and promises of support in whatever was undertaken. The dinner was thoroughly enjoyed by all, and to many of those present the familiar faces round the board recalled the palmy days of the old organization, whose membership at one time reached 280.

When the period of coffee and segars was reached, Mr. Holtzer rose and stated briefly the object for which they had come together. He felt that some sort of an organization among the electrical fraternity would be profitable and enjoyable to all, and while he did not propose anything in the shape of a resurrection of the old club, would like to have an expression of opinion from those present as to the best means to be adopted to attain their object.

Mr. W. J. Denver, of the New England Telephone Company, was appointed toastmaster, and, after recalling some amusing reminiscences of the old club, and expressing his hearty sympathy with the movement on foot, called on a number of those present for an expression of opinion. Among those who responded were Mr. Frank Ridlon, Col. E. Hewins, Mr. J. M. Orford, Mr. E. I. Farnum, Mr. G. L. Lang, Mr. H. G. Tuckerman, Mr. E. L. Caldwell, Mr. G. W. Adams, Mr. R. F. Ross, Mr. W. A. Hathaway and Mr. W. S. Key.

The general opinion, as expressed at the meeting, favored an informal organization, for the present at least, and that the meetings should be held monthly or quarterly, as the majority might decide, and should be in the nature of a dining club, to be followed by the reading of papers on electrical subjects of current interest, or other entertainment.

The main idea was to get together, now and then, for a social reunion and the interchange of opinions, without any unnecessary formalities or expense.

This proposition was just in the form of a motion by Mr. Farnum, and unanimously adopted. Mr. Denver was asked to act as chairman of a committee on further organization, and appointed as his associates, Col. Hewins, Mr. Holtzer, Mr. Ridlon and Mr. Ross.

With the understanding that members would hold themselves in readiness to attend the next meeting at the call of the secretary, the party adjourned with many expressions of congratulation and good will.

Among those present were:

W. J. Denver, Frank Ridlon, J. M. Orford, C. W. Gates, W. S. Hill, F. M. Kimball, W. D. Warner, E. L. Caldwell, R. F. Ross, S. G. Stiness, W. E. Holmes, Col. E. H. Hewins, E. I. Farnum, W. S. Key, F. E. Donahoe, H. G. Tuckerman, F. S. Palmer, E. S. Pillsbury, G. L. Lang, Chas. Holtzer, F. Boynton, G. W. Adams, W. A. Hathaway, C. R. Remington, S. W. Leedon.

Who Has an Index to Spare?

A subscriber of the ELECTRICAL REVIEW will pay 25 cents for one copy of the index to Vol. XVIII, of the ELECTRICAL REVIEW. We hope that some of our readers can fulfill his request as our supply is exhausted.

Wall Street and the Electrical Stock Market.

The market was strong all the week on the more definite attitude of the national legislature regarding the tariff. There has been a feeling in Wall street for some weeks that the time for the turn was near at hand, and when the upward swing in the market was started by a strong bull clique, under the leadership of Sugar manipulators, there was a regular scramble of professional operators to cover their short accounts. This had the effect of working the market up to a higher basis, on which it seemed to have crystallized, owing to bullish influences which developed later—notably the liberal treatment by the Senate Finance Committee of certain of the trusts, increases in railroad earnings and the declaration of the St. Paul Railroad Company of its regular semi-annual dividends. The bearish element in the market fought the rise on alternate days, but their efforts were not particularly potent, and many of them have been forced to book material losses. The material advances which have taken place in the Industrial stocks and the strength displayed by the railroad list have attracted the attention of capitalists, and there are evidences that the general public is commencing to take an interest in the market. While a reaction will naturally follow the advance, I do not believe that it will carry prices to the basis from which they started, and from now on look for a wider market and higher prices in all active and electrical securities.

The electrical stock market shared in the general advance, and the increased demand which came in consequence. The buying of electrical securities was to a considerable extent for investment account, as is evidenced by the comparatively heavy transactions in the better class of bonds. The strength of General Electric had a wonderfully stimulating effect on the balance of the electrical list as it was construed, as I have pointed out heretofore, to mean that there is a general improvement in electrical affairs.

General Electric opened the week at 43¾, touched 45⅛ on Friday under excellent buying and closed the week around 44. Fourty-four or 45 for a non-dividend paying industrial stock, measured by the Wall street gauge, is a high price, unless there is some prospect of a resumption of dividends. The continuation of the strength is regarded as *prima facie* evidence that the company's condition and business warrant these prices. The market in the stock is broader than that of many other active securities listed on the Exchange, and in consequence is not as susceptible to professional manipulation. The news which has been published on the stock has all been bullish, and there is no doubt in my mind but what the buying, to a considerable extent, has been for investment. The published offer to buy $200,000 preferred stock of the Electric Illuminating & Railway Trust shows how valuable General Electric's assets are in any but a panic market, and had the effect of bringing in heavy buying orders for General Electric stock. The advance in the preferred stock noted last week was maintained from start, and closed the week 4 points higher at 74 bid and 75 asked. The debenture bonds also showed strength under quite liberal transactions, advancing from 82 to 84.

Odd lots of Edison Electric Illuminating of New York sold at 92½ to 93. There was a good demand for the 5 per cent. bonds at 103 to 103⅜. The Court of Appeals has rendered a decision in favor of this company against Edward Wimple, Comptroller of the State. The General Term decided that the Comptroller's decision, opposing certain taxes on the corporation between 1886 and 1888 inclusive, would not hold, as the company is not liable to be taxed as changed.

Bell Telephone ranged between 168 and 169, until Thursday, when it jumped to 177, on the brighter prospects of its being allowed to increase its capital $30,000,000. The Massachusetts Legislature decided to give two hearings on this application.

Commercial cable declared a quarterly dividend of 1¾ per cent., payable April 2. Books close March 22 and open April 2. The company held an annual meeting on Monday, at which the old board of directors was re-elected. The annual report for the year is abstracted as follows: Gross earnings, $1,842,346; expenses, $784,600; net earnings, $1,057,746, a decrease of $41,840 as compared with 1892.

Of the inactive securities, North American was moderately traded in at 3⅞ to 4¼. American District Telegraph sold at 40; American Telegraph and Cable sold at 87¼ to 87½. Commercial Cable was bid 125 and held at 145. Postal Telegraph was bid 69.

On the Boston Exchange, Erie Telephone was strongly held around 42½; New England Telephone strengthened in the week from 49 to 50; Fort Wayne Electric was bid 3¼ and held at 4; Westinghouse Electric, first preferred, was bid 49 and held at 50; the Assenting bid 32½ and held at 33. The strength in Westinghouse securities noted last week continues.

New York, March 10. BAIN.

POLYPHASE TRANSMISSION.

(*Continued from page 125.*)

efficiency is usually given as if it had a great deal of importance, whereas, the losses in copper during 24 hours ordinarily amount to but a trifling per cent. of the total losses. The regulation and the temperature to which the insulation is subjected, and which it is able to stand, are generally not mentioned in reports of tests. The usual investigations and the papers published on the alternating current transformer may, perhaps, accurately express many facts in complicated formulas, but the practical bearing of these points in every-day working seems to be totally ignored.

MUTUAL INDUCTION.

If two circuits be run on the same pole line they act as a transformer in which one circuit carrying current may act as a primary and induce electro-motive force in the other as a secondary. If the latter circuit is connected with the same dynamo and is delivering current, its electro-motive force will be slightly raised or slightly lowered by the effects of the first circuit. Conversely, the second circuit will have similar effect upon its neighbor, raising or lowering its pressure by a slight amount. If the two circuits be connected to different dynamos which are running at slightly different speeds, then the electro-motive force induced by one circuit upon the other will sometimes increase and at other times decrease the electro-motive force of the circuit, depending upon whether the two currents at a given moment are flowing in the same or in opposite directions. This fluctuation may cause variations in the intensity of the lights supplied. It is readily detected in the service of some central stations, and is, of course, most marked at time of full load, as the induction of one circuit upon another depends upon the strength of current carried. The fluctuation due to this action may be readily distinguished from that due to slipping of belts or irregularity in engine speed, as the induction effect is due to the difference in alternations between two machines, and the speeds of the two machines are apt to vary slightly from time to time, giving a gradual variation in the rate of fluctuation of the lamps. The fluctuation due to mutual induction of lines occurs only at the end of the line and is not observed in the station, while the other causes affect the station lights also. The number of volts electro-motive force set up in one circuit by a parallel circuit depends upon the current, the distance which the lines are parallel and upon the relative positions of the four conductors. The distance between wires may be six inches or six feet without affecting the mutual induction, provided the relative positions be unchanged. Several dispositions of circuits are shown in the accompanying figures, and the number of volts per thousand feet at 7,200 and at 16,000 alternations, which are induced in either circuit by one ampere in the other, are given in connection with each figure. The number of volts required for producing objectionable flickering in the light depends upon the voltage of the lamps in service, the efficiency at which they are run and the general surroundings in which they are placed, notably the relation of lamps to reflectors, white walls, etc., and the general disposition of the customer.

An electro-motive force of one-half per cent. induced in one circuit by another can in some cases be detected, and usually more than one or two per cent. will cause objectionable flickering.

METHODS OF REDUCING MUTUAL INDUCTION AND SELF-INDUCTION.

The mutual induction is reduced by bringing the wires in each circuit close together and separating the circuits. The effect of this mutual induction may be neutralized by crossing one of the lines at its middle point so that induction in the first half of the line is counteracted by the induction in the second half. It is readily noted that the effect of self-induction in a circuit is reduced as the wires are brought close together or if each conductor be divided into several wires in multiple and separated. The effect of self-induction is diminished as the number of alternations is reduced. The following points are also to be noted in connection with inductive drop. If the power factor be nearly 100 per cent. the inductive drop increases as the square of the counter electro motive force. If the electro-motive force of the circuit be increased and the same power be delivered over the same circuit, the per cent. counter electro-motive force decreases as the square of the electro-motive force delivered, and the inductive drop decreases approximately as the fourth power. If the number of alternations be decreased the counter electro-motive force decreases directly and the inductive drop decreases as the square. The inductive drop at 7,200 alternations is less than one-fourth of that for 16,000 alternations for ordinary power factors.

CAPACITY IN LINES.

The static capacity in ordinary lines is usually small, and its effect is not of importance unless the line be very long or the pressure be very high. The general effect of capacity in the line or of connecting condensers to the line is to lessen the current from the generator which is required for supplying inductive load and to reduce the drop due to self-induction. The use of condensers for this purpose may lead to very considerable gains in circuits where the self-induction of line or of load becomes considerable. If an inductive circuit or transformer supply current to condensers the electro-motive force may increase instead of decreasing, as it does with inductive load.

POLYPHASE CIRCUITS.

The subjects which have so far been considered apply to single-phase as well as to polyphase circuits. The effects of self-induction will be brought to the attention of the electrical engineer much more prominently in connection with polyphase work, however, because larger alternating current enterprises will be carried out with the polyphase system, and power work involving variable power factors will be a large element in this system. There are in addition several problems which relate distinctively to polyphase working. One of these is the most suitable number of phases to be used. The two-phase system and the three-phase system are both in operation, and while it is admitted by the adherents of each system that there is no fundamental difference between them, yet each has specific characteristics giving particular advantages.

ADVANTAGES OF THREE PHASES.

In transmission it has been recently emphasized by a good many people that the single-phase system and the two-phase system require the same weight of copper, and that the three-phase three-wire system requires 25 per cent. less for transmitting power under similar conditions with the same maximum electro-motive force. This places an advantage on the side of the three-phase system which in many cases is of very considerable importance. The aggregate advantage, however, is greater than 25 per cent. A two-phase system laid out for the greatest economy requires that the interest on the cost of conductors shall equal the cost of the power lost. If the three-phase system be substituted the loss may remain the same and the copper will cost 25 per cent. less. This does not give the best relation between cost of copper and loss of power, so that a more economic adjustment is evidently possible.

It has also been shown that the self-induction of a three-phase three-wire circuit for transmitting under similar conditions of electro-motive force is only 57 per cent. of that which is incident to the two-phase four-wire circuit. When the power factor is high the effect of self-induction of line upon regulation varies approximately as the square of the counter electro-motive force. The drop due to the self-induction of a three-phase circuit is, therefore, only about one-third of a single-phase or two-phase circuit. This is a second advantage for the three-phase system which is of great value. A further advantage of three instead of four wires is the reduced cost of insulators and pole construction, the reduced losses due to leakage, etc.

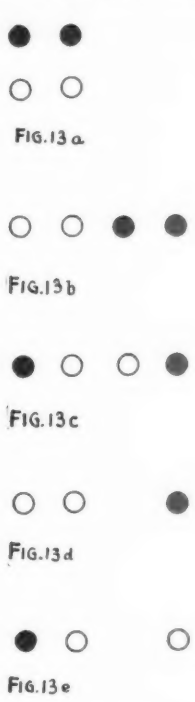


FIG. 13a	16000 ALT.	.035 VOLTS
	7200 ALT.	.016 VOLTS
FIG. 13b	16000 ALT.	.015 VOLTS
	7200 ALT.	.0065 VOLTS
FIG. 13c	16000 ALT.	.070 VOLTS
	7200 ALT.	.032 VOLTS
FIG. 13d	16000 ALT.	.006 VOLTS
	7200 ALT.	.0021 VOLTS
FIG. 13e	16000 ALT.	.112 VOLTS
	7200 ALT.	.050 VOLTS

VOLTS IN ONE CIRCUIT INDUCED PER 1000 FT PER AMPERE IN THE SECOND CIRCUIT

ADVANTAGES OF TWO PHASES.

An important point of difference between the two systems is the effect of loading one branch of the system more heavily than the others, as is common in incandescent lighting. One of the statements which remain uncontroverted in Professor Forbes' recent comprehensive and remarkable paper upon the electrical transmission of power at Niagara Falls, is in reference to the difference of regulation in dynamos for two-phase and for three-phase alternating currents. He gives the result of tests showing that the circuits of a three-phase generator differ greatly in pressure if they are not equally loaded, and states that having considered these points the directors of the company determined to reject the three-phase system. These results agree fairly well with tests which I have made. The relative regulation of the two types of machine depends very largely, of course, upon the character of the construction. Although it is not just to condemn one system because a certain construction is bad, yet the theoretical and practical tendencies toward the evil are largely removed by discarding the three-phase type.

If independent regulation of circuits is necessary one circuit can be given the proper pressure directly from the dynamo and the other circuits may be raised or lowered as may be required. This involves apparatus for regulating two circuits if the station be operated by the three-phase system, and only one circuit if the two-phase system is in use.

In a system where incandescent lighting is to be a prominent feature, or where load of any kind may be required upon one circuit and not on the other, the two-phase system has, therefore, a decided advantage in station regulation over the three-phase system. Another advantage of a two-phase circuit is that the load is separated into two divisions instead of three divisions, which is in general much simpler. A further advantage of the two-phase is in the reduction of potential for motors. Two transformers are sufficient in the two-phase system, whereas three transformers are commonly used in the three-phase system. The two transformers which would be required for small motors will cost considerably less than the three transformers which would be required on the three-phase system, and the loss in transformation will be much less as there is not much difference in the cost of small transformers of slightly different sizes, and the large sizes are more efficient. The ease and simplicity of installation is also a gain for the two-phase arrangement.

A NEW SYSTEM.

In considering the marked advantages of the two-phase system for distribution and of the three-phase system for transmission, it occurred to me that a combination of the two systems might secure the advantages of both in a combined system, and I have worked out a simple and effective method of accomplishing this result. It is well known that if two electro-motive forces differing in phase be connected in series that the resulting electro-motive force will in general differ in value and in phase from either of its components. If two electro-motive forces differing in phase 90 degrees be connected in series, the resultant electro-motive force is represented in direction and magnitude by the hypothenuse of a right angle triangle, of which the two sides are the two component electro-motive forces. Thus, in Fig. 14, if AO and OB are two electro-motive forces at right angles, and these electro-motive forces be connected in series, the resultant is the line AB, of different phase from either of the components. It is a simple matter to so proportion the components that OB is equal to one-half of AB, as shown in the diagram. In a similar manner it is readily seen that the same electro-motive force OA may be combined with OC, which differs from it by 90 degrees (but is equal and opposite to OB) in such a way as to give AC equal to AB, but differing in direction. BO and OC added together give BC. The electro-motive force BC may, therefore, be combined with the electro-motive force AO at right angles to it in such a way as to give additional electro-motive forces AB and CA, which, in connection with BC, give three equal electro-motive forces 120 degrees apart. This is the relation of electro-motive forces in the three-phase system.

The application of this arrangement to transformers is illustrated in the accompanying Figs. 15 and 16. The primaries of two transformers are connected to a generator giving two-phase current. The secondary electro-motive forces, therefore, differ 90 degrees. One secondary is made equal to 100 turns and a loop is brought out at its middle point, giving 50 turns at each side. The second secondary has 87 turns, which is approximately equal to 50 multiplied by the square root of three. One end of the circuit is connected with the middle point of the secondary of the first transformer, as shown, and the three free terminals will then deliver electro-motive forces differing in phase 120 degrees. If the electro-motive force on each primary be 1,000 volts and on one secondary 100 volts and on the other 87 volts, then the electro-motive force measured between any two secondary terminals will be 100 volts. This three-phase circuit is adapted for operating three-phase motors. In a system of transmission two-phase currents at the generator may be converted into three-phase currents, as shown in Fig. 18, and the windings may be such that the electro-motive force is raised for transmission. The currents are then transmitted by three phases, effecting economy in copper. At the other end of the line a similar arrangement of transformers may be used for converting from the three-phase to the two-phase system. The two-phase currents may then be used for the operation of two-phase motors, or the circuits may be independently loaded with lamps, or otherwise. If lamps be placed on the transformer, which supplies directly from its two terminals, the transmission is directly from the generator without affecting in any way the other circuit, as the generator terminals are connected directly to the first primaries, and the secondaries of the raising transformer are connected directly to the primaries of the lowering transformer, and the current from this is taken directly to the load. On the other hand, if the other circuit be loaded the action here will also be on its own generator circuit without affecting the first. The current from the raising transformer in this circuit passes to the middle of the secondary of the other transformer, where it divides and flows in parallel through the two parts of the coil and two of the lines. As one-half of the current flows through each part of the secondary coil in opposite directions, the self-induction is completely neutralized and the transformers in this circuit are independent of the operation of the other circuit. It is to be noted that under this condition the line electro-motive force delivered by this transformer is only 87 per cent. of that delivered by the first transformer. The lower electro-motive force, however, is compensated for by the fact that the current on one side is passed through two of the lines in parallel, thus reducing the resistance of the circuit and compensating for the slightly lower electro-motive force.

The effect upon the regulation of the generator when two-phase circuits at the end of a three-phase transmission line are independently loaded is found, both by theory and test, to be the same that prevails when the load is placed directly upon the corresponding circuit of the generator. A modification of this system is found in the arrangement where the three-phase current is produced in the generator and transmitted over three wires to the reducing transformers. These transformers may be arranged as described for producing two phases (Fig. 19). Loads may be placed upon either of the two-phase circuits, and practically the same regulation in the generator will result that would have resulted if the generator itself had been wound for two phases and one of these circuits loaded. In this way it is possible to place lighting load upon a three-phase generator in two instead of three units, and to avoid the bad

regulation in the generator due to unequal loading.

A similar arrangement of two transformers may be used for converting three phases of one potential into three phases of another potential. This arrangement is shown in the accompanying Fig. 17.

The efficiency of two transformers arranged for converting from two-phase to three-phase is reduced below that when working independently on ordinary loads by an insignificant amount. If the efficiency in ordinary working is, say, 97.5 per

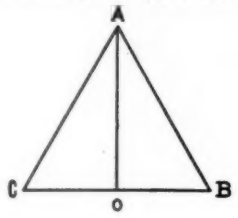


FIG.14

cent., it would be reduced to 97.4 per cent. in converting from one number of phases to the other.

The Tesla polyphase system, in which the largest electrical enterprises are seeking a realization, adapts itself with marvelous facility not only to all branches of electrical industry but also by the transformation of its phases to the utilization of three phases for gaining the highest economy in transmission, and of two phases for securing the maximum advantages in distribution.

DISCUSSION.

Professor Forbes: It gives me great pleasure to speak on the exceedingly interesting paper which has been read to us by Mr. Scott. The paper has really several totally distinct points of interest. Let us begin with the last part first, that is to say, I would like to say a few words simply to express the admiration I am sure everyone has felt for the great ingenuity which Mr. Scott has displayed in working out this beautiful arrangement of a combination of the two-phase and three-phase systems together. We must all admit that it is an extremely beautiful idea and appears on the face of it to be a feasible method. With regard to the practicability of it, I think Mr. Scott will agree with me that it must be left to the test of experience before we can say whether it is a satisfactory method of working, as satisfactory as the two-phase or three-phase systems separately. On the face of it it looks as if it were so.

I confess I do not appreciate so much as

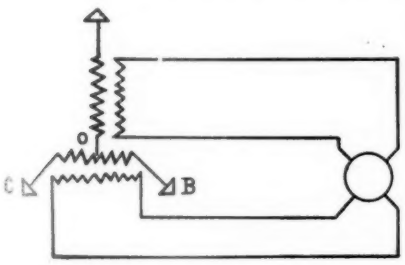


FIG.15

he seems to do the superior advantages of the three-phase system for transmission over long distances. It seems to me that the two systems, so far as we can find out in practice, as to their economy, etc., have little advantage one over the other. That is the conclusion I have come to, but Mr. Scott and others hold different opinions. If the opinion be right that the three-phase system has a distinct advantage over the two-phase, then such a scheme as Mr. Scott's ought to prove of great value.

I am sure that if there are any members of the Convention present who are devoted to the direct-current system, and determined never to hold any other opinion, whatever may happen, they will be extremely pleased to learn all the apparently intricate calculations and investigations that have to be made by the ordinary electrical engineer in dealing with the alternating current; but, as a matter of fact, many of these problems and apparent difficulties of calculation to which Mr. Scott has alluded do not become very important in the ordinary electric lighting or power station work with alternating currents of moderate dimensions. But these matters of the self-induction of the line, and the influence of different circuits upon each other, become of the very utmost importance when we are dealing with the transmission of power over great distances and on a large scale, and carrying a large amount of current through our mains. I need hardly say that, in the course of the last year or two, in connection with the transmission of power at Niagara it has been my duty to go into these points that Mr. Scott has touched upon, very fully indeed; and in a large problem like that the importance of these incidental matters to the alternating current, the dropping volts, the self-induction of the loop circuit of the line, etc., are so important that one cannot spend too much time in investigating them prior to the establishing of the plant. I have, in the course of this work, prepared for my own use a variety of tables and curves, illustrating the effects and enabling one to get the results in a particular case at a moment's glance, and it has been my purpose to publish these tables and curves for the use of others; but Mr. Scott has gone a long way to make this unnecessary.

I would particularly thank Mr. Scott for this diagram which shows the inductive electro-motive force in volts per ampere per thousand alternations per thousand feet of circuit at different distances between the centers. The compactness of that diagram is extremely beautiful, and I am sure that it will be of greatest value to engineers who are planning large power distribution plants in the future.

Mr. Scott has mentioned the name of Mr. Kennelly as having worked in this line. Any paper presented to the Convention on the subject which did not mention Mr. Kennelly's name would be defective. Of all the beautiful expositions of profound mathematical work in the simplest language,

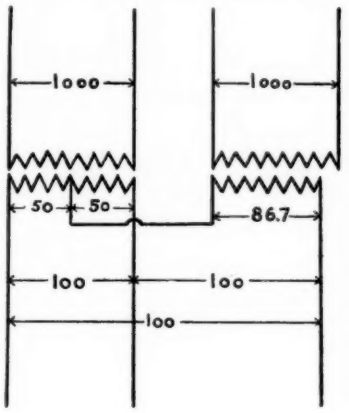


FIG. 16

which can be understood by any student in our technical colleges, there is nothing in the literature of the day to come up to the writings of Mr. Kennelly for the last year or so. I think if we take this paper of Mr. Scott's in conjunction with those which have been written by Mr. Kennelly on the same subject, any engineer has got before him all that is required for calculating the effects of self-induction and capacity upon the circuit; that is to say, upon the efficiency of the circuit and upon the dropping volts on the circuit. A little more has to be done, however, and that is the fact of resonance. The question of self-induction in the circuit is too full. We first have to deal, as Mr. Scott pointed out, with the whole circuit as forming one loop within which lines of force are formed which cut both conductors, and, therefore, produce electro-motive force, and then you have to consider the back electro-motive force which is induced in the conductors themselves. Now, if we have a conductor, an inch in diameter, we will say, that was built up of a number of wires, a current suddenly started in these would induce a back electro-

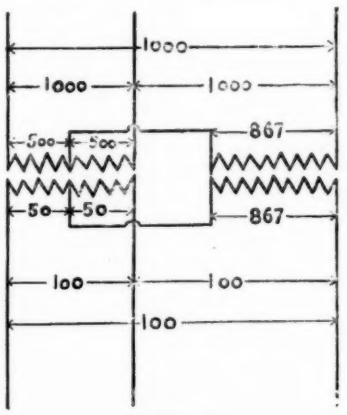


FIG. 17.

motive force in each of the others, and, therefore, every one of these wires would be acted on by the others, but it is obvious that the central wire of the bundle would be acted upon more by the others than any other; and, therefore, the back electro-motive force would be the greatest in the center of the bundle. Instead of a bundle of wires we have a solid conductor, but the effects remain the same and the back electro-motive force in the center of the conductor prevents the current from passing through the conductor, and as it has to pass over the outside of the conductor there is a resistance to the passage of the current, and that is the skin resistance. These two elements have to be taken care of, and also the question of capacity. Capacity may tend to diminish the drop in the line. Now, in regard to the lines of force that are formed

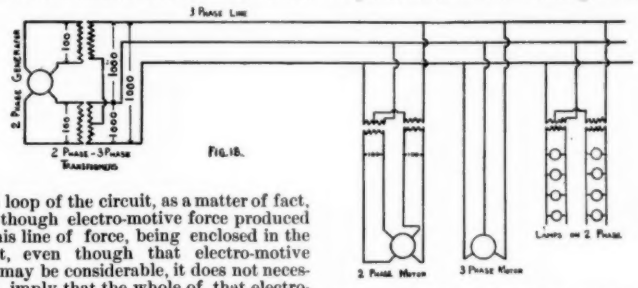


FIG.18.

in the loop of the circuit, as a matter of fact, even though electro-motive force produced by this line of force, being enclosed in the circuit, even though that electro-motive force may be considerable, it does not necessarily imply that the whole of that electro-motive force is taken off from the applied electro-motive force. That is to say, suppose we found in a long circuit going from Niagara to Buffalo, that there were 1,000 volts in the circuit due to this self-induction, that does not necessarily imply that there is a drop of 1,000 volts, because from the sketches which Mr. Scott showed you the electro-motive force is not in phase with the current. In fact, the chances are that it is nearly 90 degrees away, and, therefore, the actual drop is much less than that. But here is a case which we have to consider and which is of the utmost importance.

Mr. Scott has spoken of the interference of separate circuits upon each other. If he had considered the question of these circuits, two different circuits, being the circuits of a two-phase circuit of a distribution, one circuit being a quarter of a period behind the other, then we have a very serious interference. Suppose this current is changed from positive to negative. At the moment when it is zero there is a maximum electro-motive force cutting the field, and that maximum electro-motive force cuts the other conductors which carry the current a quarter of a phase behind, at the very moment when that current is at its maximum. Therefore, the electro-motive force induced by one circuit upon the other is in phase, with one current in the other conductor, and the pole of the electro-motive force thus generated is a drop in the electro-motive force of the other circuit. For this reason you will see that it is of the utmost importance in a large station where the polyphase system is em-

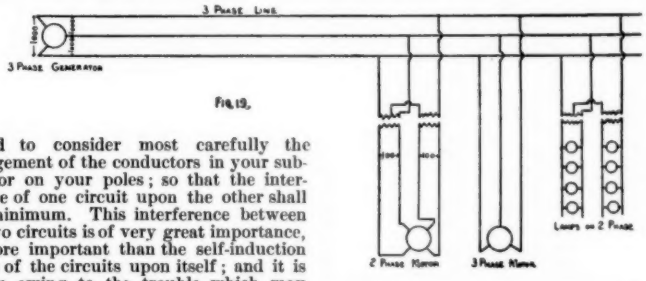


FIG.19.

ployed to consider most carefully the arrangement of the conductors in your subways or on your poles; so that the interference of one circuit upon the other shall be a minimum. This interference between the two circuits is of very great importance, far more important than the self-induction of one of the circuits upon itself; and it is largely owing to the trouble which may arise from this and largely owing to the trouble which may arise from capacity, that I have to look most carefully into the subject and have found the lower the frequency the less do these things trouble us. It is largely, I say, owing to these reasons that we determined at Niagara to reduce in our dynamos the frequency to as low a point as was consistent with the construction of good, sound generators; and that is largely the reason why we have reduced our frequency to so low as 25 periods a second.

I take this opportunity to say a few words not directly on the subject in hand. Many persons have been surprised that the Cataract Construction Company and myself have taken no notice of numerous fault findings and misstatements that have, at different times, appeared with regard to our work at Niagara. We have not the slightest intention of paying any attention to these whatever. All that we want to do is to have our work done properly, and it is of no moment to us what opinions others may hold. We have not adopted any particular system. We believe that by the construction of dynamos of two phases we shall be able to meet all the requirements that will come to us. We are, however, ready to utilize every invention of merit. We have ordered the construction of a certain number of dynamos by the Westinghouse company; they are devoting their energies unsparingly to producing splendid machines, and we are confident of the final result. I think it advisable to make these remarks, because it is not often that one happens to meet one's friends in this way, and I am glad to explain why we do not consider it necessary to take any notice of such criticisms as have occurred.

Professor Rowland: Gentlemen, it is with great pleasure that I rise to say a few words with regard to this invention of Mr. Scott's. As far as I can see, it is one of the finest things that has come out in recent years in this country. Very few of us expected that we would be so soon able to tranform a two-phase system into a three-phase, or any number of phases. It gives us possibilities in the working of motors, etc., which we had not before, and I think this paper marks an era in the science of the polyphase system. It is curious that I happened to be writing a paper at the present time upon something on this very subject—the subject of transforming one number of phases into another number; that is, two phases into three phases, etc. I think I have solved the problem of transforming any polyphase system into any other polyphase, also with any different period of the current. That is a little broader than this is; at the same time my method is not in any way so practical as this, and is not so simple, and in no way bears comparison with it. It has, however, a little broader aspect, as I can change the period of the current at the same time that the number of phases is changed. It is not, however practical, like this beautiful method of Mr. Scott's.

In regard to the period of the current, this is an important question in long-distance transmission in the use of motors of the Tesla type or the alternating current motors of all sorts. Although I quite agree with Professor Forbes that a low period is very excellent in many respects, I was not able to agree with him as to the exact figures—when you get down very low things happen that would not happen with a reasonable frequency. I have been studying the subject, especially of the Tesla motor, and I see no reason in that motor for lowering the frequency, as good motors can be made for a reasonably high frequency as for a low one. When it comes to the subject of transformers, of course, the larger the period the better the transformers become, and the smaller the period of oscillations of the current the larger the transformers, etc.; so that there is some limit to this question of frequency. I have only to say once more that this invention of Mr. Scott's seems to me to mark an era in the science of this current.

Mr. Spencer: In the formulas of Mr. Scott he assumes his load at the end of the conductors. In actual practice the distribution of the load is over the entire conductor, except in using the feeder system in the mains, and, of course, this would not come in. In nine cases out of 10 the load is distributed over the conductor and not from the station. I do not see how it is possible to apply his load factor to that case. Of course we must assume that each converter adds to the load factor. I would like to ask how he would apply that load factor when the load is distributed along the line, so that we can get an accurate idea of the size of the conductor or percentage of drop in the line.

Mr. Scott: In the case in which the load on the circuit is distributed becomes more complicated, it would be necessary then to take each part of the circuit and calculate the amount of electro-motive force in it, and so on for each part of the circuit, and the problem in general would be very similar to the calculation of the drop in different parts of a continuous current circuit, which is much broken up, and the load distributed and the wires interconnected. It becomes quite a difficult problem to apply the simple Ohm's law in a case of

that kind. In practice, however, the counter electro-motive force in primary circuits of 1,000 or 2,000 volts extends over a small area—a mile or so—and with ordinary currents up to 100 amperes is not such as to cause effects of very great practical importance. That is shown from the fact that in the circuits ordinarily operated these effects have not been very prominent. They have not interfered with the working of central stations of pretty large capacity. For instance, at the World's Fair the circuits there were the largest incandescent lighting plant which has been installed; and one of the lessons of the World's Fair is that a large alternating incandescent central station can be operated, and that these effects of self-induction and capacity, which under certain conditions may give rise to difficulties, in the operation of this large central station, gave no disadvantageous effects. In general, the inductive drop in circuits for incandescent lighting is only a small percentage of the ohmic drop; and it is an extreme case when the drop due to induction equals the drop due to the resistance of the conductor.

I was a little afraid, in presenting some of the subjects taken up in this paper, that there would be somewhat of a scare with regard to the use of alternating currents, and that it would be apprehended that they would give rise to some trouble; but usually, if a subject of this kind is taken up in the right way, the difficulties may be overcome by the right kind of engineering; and the observance of a few of the precautions mentioned, the running of two wires in the circuit close together and some other practical points of that kind, which will readily suggest themselves, may be handled successfully. If one studies the diagrams and makes use of them, and takes his own problems and works out the exact electro-motive force and the exact effects of the conditions he has, they will give him an accurate notion of the extent of these effects.

I heartily agree with Mr. Forbes in his remarks concerning Mr. Kennelly. The article which he brought out a month or two ago, treating the problem of the alternating current circuit in its relation both to self-induction and capacity and insulation resistance, is a very comprehensive and elegant solution of the general problem. In ordinary working, however, capacity will have very little effect upon the practical conditions with which the ordinary central station man will come in contact. It is only when we get up to very high voltages or very long lines that the effect of capacity will enter in a marked degree into the operation of the circuits. The so-called skin resistance, or increase of resistance of the conductor, due to the ununiform distribution of electric currents referred to by Professor Forbes, in ordinary working may be very largely neglected. This effect decreases as the number of alternations increases, so that with 16,000 alternations, the increase in resistance in a conductor, half an inch in diameter, is only three per cent., or thereabouts, so that ordinarily this is an insignificant amount. In order that the resistance shall not exceed this, with low alternations, three or four thousand, the diameter of the wire must be something like an inch or an inch and a half.

Professor Forbes pointed out that the action of one circuit on the other is such that the electro-motive force induced is in phase with the electro-motive force on the first circuit, and the latter causes a greater drop than would be caused if the two circuits were at the same phase. This is true, and the reflex action is an interesting one; the action of one circuit on the other is to decrease the electro-motive force, and the reverse action of the second circuit on the first is to increase its electro-motive force, so that circuits become unbalanced—the electro-motive force of one circuit increasing, and that of the other decreasing.

Mr. Stilwell, of Pittsburgh: I have been pleased to note the interest which those members of the association who are managers of central stations have taken in Mr. Scott's paper. One of the things which manufacturing companies have to contend with, and one of the obstacles which is in the way of a more rapid development of new apparatus—the turning out of practical alternating current motors—is the fact that the time of a considerable part of the electrical staff of the large electrical companies is taken up in answering questions, largely in the line of the points covered by Mr. Scott's paper. The operators of central stations employing alternating currents have run across these phenomena from time to time. He has not understood them—none of us have understood them thoroughly until recently—and he naturally calls upon the engineers of the manufacturing companies to help him explain them. Every member of the association should make it his business to study this paper, and there is nothing in it which any central station manager need fail to understand. I think it is not out of place to congratulate the association upon the fact that at this meeting—and, I think, for the first time—an invention of great scientific interest, as well as great practical importance, has been first laid before this body. A year or two ago it would, undoubtedly, have first been presented to the American Institute of Electrical Engineers. I think it is a compliment to the association, and an evidence of the fact that the efforts of the association to study these problems is understood and appreciated.

The paper is specially important in view of the fact that we are just now approaching the time in this country when there will be a necessity to supply arc service and motor service from our incandescent circuits. Many of you have already felt the pressure which is being exerted to drive you underground with your circuits. When that time comes the importance of being able to supply all kinds of service from one system of conductors will be great.

In regard to criticism made by Professor Forbes, there has been some controversy over certain points which are familiar to the electrical fraternity. We claim that the plans at Niagara Falls are substantially those laid out by Mr. Tesla several years ago. The statement we issued, as nearly as I can recall, was this: The plans which have been adopted by the Cataract Construction Company for their work at Niagara Falls are simply the Tesla polyphase system, as developed by the technical staff of the Westinghouse Electric and Manufacturing Company. Professor Forbes says that statement is not correct. From a lawyer's standpoint it is incorrect in this respect—my attention having since been called to it. The Niagara Falls company have ordered three two-phase generators; they have not ordered any motors. These latter will be one or two-phase. If they are two-phase the statement stands without amendment; if they are one-phase it also stands without amendment, because the language is this—the Tesla polyphase system as developed by the Westinghouse Company. We made no small exhibit at the World's Fair in the power transmission department. We had a 500 horse-power generator driving a 500 horse-power motor and a smaller one. It was the alternating current system. It was of the constant potential type, and the motors there shown were of the two-phase variety. The frequency was 30 periods per second, or 3,600 alternations per minute. The potential was 400 or 500 volts. We showed motors of the non-synchronous and synchronous type. We did not show single-phase motors in operation, but they could have been run by these generators. In the case of Niagara Falls, we have the frequency reduced to 25 periods, but this difference is hardly sufficient to differentiate between the two systems. I do not suppose that in the strict sense any difference in frequency could be taken as a line of demarkation between the two systems. The potential at Chicago was 400 volts and at Niagara it will be 2,000 volts, for certain reasons. The difference of potential does not differentiate between two systems; it is selected with reference to the distance over which we are to transmit the power. Electrically speaking, these are the only differences between the plant at Chicago and the one at Niagara.

Professor Rowland: As I know all about this Niagara Falls affair, and know exactly what was recommended and what was not recommended, I may say that Mr. Stilwell's statement is correct. The things advocated are not the things which are now there.

Jacksonville, Fla., is clamorous for an electric street railway.

The Lunkenheimer Graphite Sight Feed Lubricator.

The Lunkenheimer company, Cincinnati, O., have just brought out a novel sight feed lubricator which employs pure flake graphite as a lubricant. It is now pretty generally understood that graphite is far superior to oil as a lubricant when properly applied to steam engine cylinders, but, being a dry powder and not mixing well with oil, the difficulty has been to properly supply it to steam chests and cylinders of engines and pumps.

The Lunkenheimer company believe they have succeeded in constructing a lubricator that not only feeds the graphite automatically and continuously in desired quantities, but also does it visibly, by passing through a sight feed. The cup should be attached like any ordinary sight feed oil lubricator to the steam pipe above the throttle, but can also be attached below the throttle or on the steam chest, with the upper steam connection above the throttle. A sight feed oil lubricator becomes entirely unnecessary and superfluous when an engine is provided with a graphite cup, but the Lunkenheimer company recommend in connection with it the use of one of their glass body oil pumps, which can be attached either on the steam pipe, throttle or steam chest.

As a small quantity of graphite will last a long time, a continuous feeding of it is not necessary; therefore, its use becomes very economical, as the feed can be occasionally shut off.

The illustrations herewith give a good idea of this new graphite sight feed lubricator. Referring to Fig. 1, which is an exterior view of the device, A is the graphite

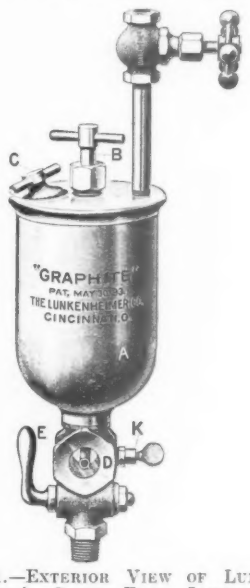


FIG. 1.—EXTERIOR VIEW OF LUNKENHEIMER'S SIGHT FEED LUBRICATOR, SHOWING GENERAL APPEARANCE OF CUP.

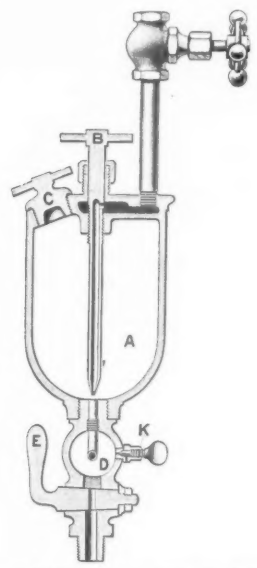


FIG. 2.—SECTIONAL VIEW OF LUNKENHEIMER'S SIGHT FEED LUBRICATOR, SHOWING INTERIOR CONSTRUCTION.

reservoir, B the graphite regulating valve, C the filling plug, D a bull's eye sight feed chamber, E the feed regulating valve, and K the drain valve. Fig. 2 is correspondingly lettered, and is a sectional view.

THE WASHINGTON CONVENTION.

SOME ADDITIONAL NOTES ABOUT EXHIBITS AND EXHIBITORS—NEWS AND COMMENT.

Mr. Frank R. Ford was there for the La Roche Electrical Works, of Philadelphia.

Everybody missed P. C. Ackerman, of the American Electrical Works, who didn't get there.

F. G. Bolles, of Washington, was active in presenting the interests of various companies he is representing.

Mr. Frank Parsons, of Boston, was present in the interest of the Case Engine Company, and the Davidson ventilating fan.

Mr. J. S. Crider, of the Washington Carbon Company, exhibited sections of a new cored carbon that attracted all the practical electric light men.

Where do you suppose Mr. W. R. Brixey was? His absence created a great deal of talk about "Kerite" wire. W. R. B. was always a clever man.

The Simplex wires were not exhibited but General Manager J. H. Mason, of the Simplex Electrical Company, Boston, was there and that was sufficient.

Chas. D. Shain, of New York, represented the Siemens & Halske Electric Company, of America, as well as other companies for which he is selling agent.

Jim Godfrey was off selling something somewhere else, but Frank Harrington looked after the interests of the New York Insulated Wire Company in great shape.

The coiled filament type of Buckeye incandescent lamps were burning brightly in several prominent places. Mr. G. R. Lean represented the Buckeye Electric Company.

The Helios Electric Company, of Philadelphia, was represented by Mr. Thomas Spencer, who gave a great deal of information about his company's arc lamps and other specialties.

The Indiana Rubber and Insulated Wire Company, Marion, Ind., exhibited samples of its products, and was represented by its Eastern sales agent, Mr. Frank A. Brigham, of Boston.

The Ries Electrical Specialty Company, of Baltimore, was present in the person of Mr. Elias Ries, whose self-regulating sockets for direct and alternating current incandescent lamps were exhibited.

Diehl & Company, of New York, exhibited a handsome ceiling fan motor and electrolier combined. This firm was represented by Mr. E. H. Bennett, and by Jordan, McLeod & Company, of Washington.

Mr. Louis Stirn had a working exhibit of his universal pull sockets at the landing on the main staircase of the Ebbitt House. This specialty is made by the Universal Pull Socket and Switch Company, of New York.

The Automatic Switch Company, Baltimore, Md., exhibited a very successful electric car heater in the ELECTRICAL REVIEW parlor. Mr. F. Della Torre politely explained the workings of the device to many interested inquirers.

Lieut. J. A. Tobin, United States Navy, extended the hospitality of the Army and Navy Club to a number of his electrical friends. Lieut. Tobin is widely known as the inventor of the Tobin bronze and takes quite an interest in scientific matters.

Mr. A. A. Knudson tested coils of his new "Ideal" wire that had lain in water for weeks. His company claims that in many respects this wire is superior to rubber, and that it will outlast rubber when exposed to the atmosphere, and at the same time retain its high insulating qualities.

Chas. A. Schieren, Jr., E. P. Atkinson and G. H. Fisher were there for Chas. A. Schieren & Company, New York. Since young Mr. Schieren so successfully managed his father's campaign in the Brooklyn mayoralty contest, they say he can explain the merits of Schieren belting in an irresistible manner.

The switch exhibit of the W. S. Hill Electrical Company, that was admired by all, is now at the office of their representative, the Elson and Brewster Engineering Company, 141 Liberty street, New York city, where it is attracting a great deal of attention. The new lightning arrester is causing much favorable comment.

Doubleday, Mitchell & Company, 136 Liberty street, New York, exhibited samples of their quick-breaking switch, designed for currents of any volume, and the canvas jacket flexible conduit, that is now being so extensively used in new buildings, Mr. Chas. D. Doubleday reporting 325,000 feet now being placed in the Hotel Majestic.

A very enjoyable party of ladies and gentlemen attended the Convention, leaving New York on the Pennsylvania limited Sunday afternoon. The party was chaperoned by Col. Henry C. Davis, one of the ex-presidents of the Electric Club, and comprised the lucky number of 13. The magnificent service on this great train of the Pennsylvania company was highly appreciated, and the party arrived in Washington on time, and had a day to enjoy the Capital City before the Convention rush began.

Below are the names of the electrical and street railway journals and their representatives at Washington:

ELECTRICAL REVIEW—Chas. W. Price, Stephen L. Coles, Geo. C. Maynard, H. T. Richards, Fred. DeLand.

Electrical World—W. J. Johnston, W. D. Weaver, H. W. Frye, M. J. Sullivan, N. D. Webster.

Electrical Engineer—Geo. M. Phelps, T. C. Martin, Joseph Wetzler, Frank R. Colvin, A. C. Shaw, W. F. Hanks.

Western Electrician—W. F. Collins, J. B. O'Hara, F. L. Perry, W. F. Osborne.

Electricity—B. E. Greene, W. S. Key.

Electrical Age—W. T. Hunt.

Electrical Industries—E. L. Powers, E. E. Wood.

Electric Power—H. M. Davis.

Electrical and Street Railway Reporter—G. G. McDuff. Newton Hall.

Electrical Engineering—Fred. DeLand.

Street Railway and Electrical News—C. T. Waugh.

Street Railway Gazette—C. E. Stump, Edward Caldwell.

Street Railway Review—F. S. Kenfield.

Street Railway Journal—H. W. Pool.

Canadian Manufacturer—J. C. Gardner.

Power—H. M. Swetland.

Here are 15 journals with 36 representatives, and yet there are people who declare that the press takes no interest in conventions!

WHO WERE THERE.

The attendance at the Washington Convention of the National Electric Light Association, and where each hailed from.

THE LADIES.

Mrs. W. A. Anthony, Manchester, Conn.; Miss E. W. Armstrong, Camden, N. J.; Mrs. C. O. Baker, Jr., Newark, N. J.; Mrs. C. E. Bibber, Philadelphia; Mrs. C. A. Bragg, Philadelphia; Mrs. J. J. Burleigh, Camden, N. J.; Mrs. Willard L. Candee, New York; Miss Ethel Candee, New York; Mrs. Louis Cassier, New York; Mrs. H. E. Cooke, Cleveland; Mrs. Wm. Cooney, New York; Miss Carrie Clark, Wyoming, O.; Miss Georgie Clark, Wyoming, O.; Miss Cumming, Philadelphia; Mrs. A. J. DeCamp, Philadelphia; Miss DeCamp, Philadelphia; Mrs. L. A. Doud, Philadelphia; Mrs. S. A. Douglas, New York; Mrs. H. H. Dunlevy, Wheeling, W. Va.; Mrs. H. A. Foster, New York; Mrs. James Ferguson, Brooklyn; Mrs. M. J. Francisco, Rutland, Vt.; Mrs W. J. Hammer, New York; Mrs. H. G. Issertel, New York; Mrs. W. J. Johnston, New York; Miss Johnston, New York; Mrs. Romaine Mace, New York; Miss Mason, Boston, Mass.; Mrs. Geo. T. Manson, New York; Mrs. A. H. Manwaring, Philadelphia; Mrs. Geo. A. McKinlock, Chicago; Mrs. J. M. Orford, Boston; Miss Morris, Paterson, N. J.; Mrs. J. Noonan, Paterson, N. J.; Mrs. A. H. Patterson, New York; Mrs. Chas. W. Price, New York; Mrs. E. F. Peck, Brooklyn, N. Y.; Miss Essie Read, Chicago; Mrs. John A. Seely, New York; Mrs. E. W. Seymour, New York; Mrs. R. L. Shainwald, New York; Miss Bessie Shütte, Philadelphia; Mrs. H. J. Smith, New York; Mrs. M. J. Sullivan, Chicago; Mrs. F. D. Sweeter, Wilmington, Del.; Mrs. H. M. Swetland, New York; Mrs. Schuyler S. Wheeler, New York; Mrs. J. Wright, New York; Miss Vail, New York; Mrs. G. A. Vallee, Philadelphia; Mrs. A. M. Young, Waterbury, Conn.; Misses Ella and Lucy Young, Waterbury, Conn.

THE GENTLEMEN FROM NEW YORK.

H. C. Adams, L. R. Alberger, E. P. Atkinson, R. H. Beach, T. Beran, Wm. Bracken, Capt. W. L. Candee, Louis Cassier, S. H. Chase, Frank H. Clark, S. L. Coles, ELECTRICAL REVIEW, F. R. Colvin, R. B. Corey, G. H. Coulthurst, W. F. D. Crane, Chas. Cuttriss, H. M. Davis, Frank De Ronde, Chas. D. Doubleday, S. A. Douglas, C. T. Eshburn, C. J. Field, H. A. Foster, Henry W. Frye, N. W. Gage, Gen. E. S. Greeley, B. F. Greene, S. D. Greene, J. P. Hall, Newton Hall, W. F. Hanks, W. J. Hammer, Louis E. Howard, W. T. Hunt, H. G. Issertel, G. J. Jackson, W. J. Johnston, E. S. Keefer, A. H. Kimball, A. A. Knudson, H. Ward Leonard, C. A. Learned, F. H. Leonard, H. L. Lufkin, Romaine Mace, F. A. Magee, Geo. T. Manson, L. B. Marks, T. C. Martin, G. G. McDuff, J. McGhie, P. L. McLaren, P. W. Mitchell, George T. Moore, T. J. Murphy, W. J. Newton, W. F. Osborne, F. B. Parsons, A. H. Patterson, J. C. Pierrez, G. M. Phelps, H. W. Pool, Geo. F. Porter, Chas. W. Price, ELECTRICAL REVIEW, C. Ransom, H. D. Reed, H. T. Richards, ELECTRICAL REVIEW, F. A. Scheffler, A. L. Searles, J. A. Seely, E. W. Seymour, C. D. Shain, R. L. Shainwald, Chas. A. Schieren, Jr., H. L. Shippey, H. J. Smith, J. Elliott Smith, Louis Stirn, Robt. Stewart, G. R. Stetson, L. Stieringer, C. E. Stump, H. M. Swetland, F. Taylor, F. B. Thilow, D. Thomson, J. H. Vail, C. S. Van Nuis, C. T. Waugh, W. D. Weaver, B. R. Western, Jos. Wetzler, Dr. S. S. Wheeler, G. L. Wiley, F. H. Wilkins, E. E. Wood, Jos. Wright, J. Van Vleck, Frank Harrington.

PHILADELPHIA.

W. S. Andrews, W. Annear, J. Appleton, Sanford Belyea, C. E. Bibber, J. G. Biddle, C. A. Bragg, H. J. Buddy, Henry Clay, H. A. Cleverly, H. B. Cutter, F. W. Darlington, A. J. DeCamp, G. H. Fisher, Frank Ford, J. C. Gardiner, James Garnett, Felix Haac, J. S. Hinds, H. C. Kellogg, Jr., J. R. Lovejoy, A. H. Manwaring, A. J. Martin, J. A. Pentz, Eugene Richter, P. G. Salom, R. B. Smith, T. Carpenter Smith, Thos. Spenser, N. D. Webster, J. R. Williams, E. W. Wilkins, E. T. Wilkinson, E. G. Willyoung, W. B. Wood, Peter Wright, G. A. Vallee.

BALTIMORE, MD.

P. H. Alexander, W. F. Banfield, S. Childs, G. E. Cox, W. W. Donaldson, Dr. Louis Duncan, W. C. Darrell, C. R. Durling, D. E. Evans, C. Edwards, E. B. Gawthrop, C. C. Hughes, G. R. Holmes, A. B. James, P. Kielholtz, F. H. Knox, H. Kent McLay, J. Frank Morrison, Hugh Pattison, C. E. Phelps, C. P. Poole, John Powell, A. L. Reese, E. E. Ries, S. Reber, Prof. H. A. Rowland, Mr. Smith, F. Thomas, F. Della Torre, C. R. Young.

CHICAGO.

Edw. Caldwell, George G. Carter, Ernest L. Clark, W. F. Collins, L. K. Comstock, E. A. Cummings, Fred. DeLand, ELECTRICAL REVIEW, W. J. Ferris, J. H. Gates, C. E. Gregory, A. W. Harvey, P. H. Hover, Samuel Insull, F. S. Kenfield, H. S. Manning, Geo. A. McKinlock, J. B. O'Hara, F. L. Perry, E. L. Powers, G. L. Reiman, J. H. Shay, M. J. Sullivan, Edward Stockwell, F. S. Terry, F. Todd, C. H. Wilson, C. H. Wilmerding, M. M. Wood.

WASHINGTON, D. C.

J. R. Ash, C. H. Bowen, F. G. Bolles, Geo. S. Boudnot, J. Burkett, C. F. Chrisholm, F. H. Clarke, A. W. Clapp, G. G. Dennison, Prof. O. Dodge, Hon. A. C. Durborow, Jr., Allen R. Foote, S. Q. Hayes, M. D. Law, Wilmot Lake, Geo. C. Maynard, ELECTRICAL REVIEW, J. D. McIntire, Prof. T. C. Mendenhall, F. D. Neale, Chas. Pardoe, Robert Watson, A. Young.

BOSTON, MASS.

F. W. Brigham, Capt. Wm. Brophy, David J. Cartwright, Wm. Lee Church, Isaac H. Davis, Fred. A. Gilbert, H. P. Hall, C. I. Hills, W. S. Hill, A. L. Holden, J. H. Mason, J. M. Orford, J. L. Lucas, D. R. Urquhart, Geo. H. Poor, C. B. Price, E. A. Record, A. C. Shaw.

BRIDGEPORT, CONN.

W. C. Bryant, C. E. Carpenter, T. M. Field, H. A. Hubbell, G. B. Kirkegaard.

BROOKLYN, N. Y.

W. S. Barstow, T. E. Crossman, J. Ferguson, E. F. Peck, L. K. McLaughlin.

BUFFALO, N. Y.

J. J. Flavin, J. F. Kester, C. R. Huntley, F. P. Little, F. H. Williams.

CAMDEN, N. J.

Hon. E. A. Armstrong, J. J. Burleigh, W. E. Harrington, John W. Lyell, J. R. Williams.

CINCINNATI, O.

J. A. Cabot, C. E. Jones, E. A. Sarran.

HARRISON, N. J.

A. D. Page, W. S. Howell.

HARTFORD, CONN.

J. J. Gates, C. E. Newton, Alfred H. Pease, C. T. Hills, C. L. Tolles.

NEWARK, N. J.

C. O. Baker, Jr., F. N Crane, R. B. Cissel, R. O. Heinrich, C. H. McIntire, Edward Weston.

PITTSBURGH, PA.

O. H. Baldwin, G. H. Blaxter, J. S. Crider, A. Groetzinger, Ernest H. Heinrichs, M. Mead, C. Townley, C. F. Scott, L. B. Stilwell, N. A. Vandervort, A. J. Wurts, J. W. Marsh, F. H. Tooker.

PATERSON, N. J.

Wm. M. Brock, J. Noonan.

RICHMOND, VA.

Thos. W. Brander, Maurice Hunter, Maurice W. Thomas.

ST. LOUIS, MO.

Jas. I. Ayer, Louis Nahm, J. H. Rhotehamel.

SYRACUSE, N. Y.

H. J. Gorke, J. L. Hinds, W. J. Morrison, A. P. Seymour.

WARREN, O.

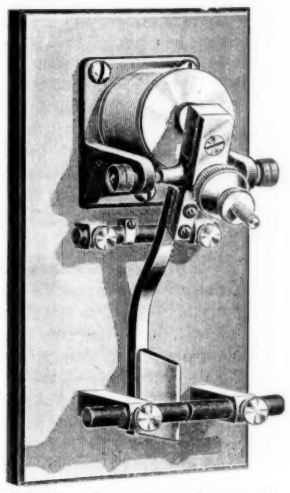
B. B. Downs, W. D. Packard.

WHEELING, W. VA.

E. Buchman, H. H. Dunlevy, E. M. Holliday.

FROM ALL AROUND.

H. J. Edgar, Atlanta, Ga.; H. W. Sexton, Anniston, Ala.; J. P. Graham, E. B. Green, W. Carnes, Memphis, Tenn.; A. M. Robertson, Minneapolis, Minn.; A. E. Worswick, Montgomery, Ala.; A. J. Jones, New Brunswick, N. J.; John R. Coffman, Northeast, Pa.; Geo. J. Jackson, Norwich, Conn.; C. I. Hague, New Haven, Conn.; Waldo A. Learned, Newton, Mass.; Jas. L. Belote, W. W. Chamberlain, Norfolk, Va.; G. T. Brown, Nashville, Tenn.; T. H. Brady, New Britain, Conn.; J. H. Findley, Ogdensburg, N. Y.; George Tobes, Olean, N. Y.; C. C. Martin, Parkersburg, W. Va.; Geo. W. Brown, Portland, Me.; M. J. Perry, Providence, R. I.; M. A. Beal, Rockford, Ill.; F. M. Hawkins, Geo. A. Redman, C. F. Burns, Rochester, N. Y.; M. J. Francisco, Rutland, Vt.; Joel Sharp, D. L. Davis, G. A. Barnard, Salem, O.; C. F. Ellis, Swissvale, Va.; A. B. Herrick, Schenectady, N. Y.; Joseph Gwynn, Steubenville, Ohio; T. P. Keck, Savannah, Ga.; W. H. Fellows, Springfield, Mo.; O. L. Mitchell, Taunton, Mass.; C. R. Faben, Jr., Toledo, O.; Frederick Nicholls, Toronto, Ont.; J. T. Ridgeway, Trenton, N. J.; C. L. Rodman, Ravenna, O.; Prof. W. A. Anthony, Vineland, N. J.; Alden M. Young, Waterbury, Conn.; J. E. Pyle, West Chester, Pa.; E. Buchanan, E. M. Holliday, H. H. Dunlevy, Wheeling, W. Va.; John J. Jennings, Wilkinsburgh, Pa.; H. H. Fairbanks, Worcester; C. R. Van Trump, F. D. Sweeter, W. Shaw, Wilmington, Del.; W. A. Clark, Wyoming, O.; R. P. Holmes, Youngstown, O.; A. J. Purinton, Stamford, Conn.; S. M. Hamill, Cleveland, O.



THE DOANE LIGHTNING ARRESTER.

Woven Wire and Graphite Brush.

One of the latest improvements in a commutator brush is one composed of woven wire and graphite, which is being put on the market by the Belknap Motor Company, of Portland, Maine. It is made of pure copper wire cloth of a special weave, put together in such a way that, while it has great flexibility, it holds its shape permanently. The inside folds of the cloth are treated with a compound of graphite so that as the brush wears the graphite furnishes the lubrication for the commutator. This brush, it is claimed, has all the advantages of the ordinary copper brushes and carbon brushes, for while it has the required conductivity, at the same time it is very easy on the commutator.

WOVEN WIRE AND GRAPHITE BRUSH.

The carbon brush has been coming into favor because it is so easy on the commutator, but it must be remembered that this advantage is secured at the sacrifice of economy, as the resistance of carbon is fifteen hundred times as great as that of copper, tests having been made showing a drop of 25 per cent. in the brushes alone, while with the combined woven wire and graphite brush the drop is said to have been inappreciable.

Another great saving comes from the fact that no grinding or fitting to the commutator is required, so there is no loss of material or time in this way, and even the stubs of worn-out brushes need not be thrown away, as they can be worked into the centers of new brushes.

The Belknap Motor Company is receiving most flattering reports from the brushes wherever they have been placed, and they are being used on nearly every type of machine on the market.

TELEPHONE NEWS AND COMMENT.

It is said to be the policy of the New England Telephone and Telegraph Company to rent telephone receivers at $1 per annum, instead of selling them outright.

There was a consultation of big telephone men in Boston recently. There were present Captain Geo. N. Stone, of Cincinnati; Messrs. Edward J. Hall and Chas. F. Cutler, of New York; Wm. D. Sargent, Brooklyn; Morris F. Tyler, of New Haven. It is presumed that the expiration of the Bell patent and the action of the Bell company and its licensees were the topics discussed.

The Metropolitan Telephone and Telegraph Company, New York, after a month's selling of receivers to the public generally, has decided to sell only to persons in its territory, which comprises New York city; therefore, all correspondence relating to the purchase of telephones growing out of the company's advertising in the ELECTRICAL REVIEW is forwarded to the company controlling the territory from which the letters emanate. This complicates and delays matters, and the anti-Bell manufacturers will be benefited.

Ex Governor Long, in his argument for the Bell company before the Mercantile Committee, Boston, said if the increase of capital asked for was granted, $10,000,000 would immediately be expended in long-distance lines, and said the Bell Telephone Company would make no objection to other telephone companies being organized. He also said there were now 5,277 stockholders in the Bell Telephone Company, of which 3,721 stockholders held less than 25 shares each. The committee will inspect the company's plant at 125 Milk street, Boston.

The Boston *News Bureau* says: It is said that the petitions which have been circulated inviting signatures to remonstrate against the granting by the Massachusetts legislature of the petition of the American Bell Telephone Company for an increase in its capital stock have a Drawbaugh origin. Mr Charles P. Searle, who signs the circular, says he has received about 1,000 signatures to his petition. Mr. Searle has drafted a bill which will probably come up at the hearing Wednesday, when the Bell Telephone case will be heard.

Mr. Parker C. Chandler, representing the Drawbaugh interests, who are asking for a charter from the legislature, states most emphatically that the Drawbaugh people are minding their own business and do not care about the amount of the Bell Telephone capitalization. In fact, the larger the amount of the Bell capitalization the more pleased those who propose to compete with it will be.

The recent reductions of royalties by the American Bell Telephone Company to its licensees for the use of the hand telephone will drop something over $200,000 out of the Western Union Telegraph Company's income. The net loss, however, to the American Bell Telephone Company by the same reduction will be more than twice this amount. But perhaps it is a small matter now, as in 1896 the contract between the Western Union and the Bell Telephone Company, under which the latter has paid the former 20 per cent. of its royalty income, or about $500,000 a year, will expire.

The Doane Lightning Arrester.

The W. S. Hill Electric Company, of 133 Oliver street, Boston, have placed upon the market the lightning arrester shown above.

In the forms of lightning arrester heretofore made, the discharge caused a short circuit by means of the arc, and this was often sufficient to cause some little damage at a portion of the line. The Doane arrester, as this new type is called, establishes the short circuit through a non-inductive resistance sufficient to limit the current that will follow the lightning discharge so as to prevent all liability to injury.

No current passes through any of the movable parts of the arrester, and it is apparent that with the limited amount of current that the carbons carry, there is practically little wear and tear on the apparatus.

The arc formed by the passage of a current of not more than five amperes between the carbons is easily extinguished and can do no possible harm.

KINDRED INTERESTS

Westinghouse, Church, Kerr & Company will soon remove their New York offices from 17 Cortlandt street to the Havemeyer Building.

Berlin Iron Bridge Company.—The Philadelphia Gas Improvement Company, of Philadelphia, Pa., have placed the order for the iron roof over their new coal shed with the Berlin Iron Bridge Company, of East Berlin, Conn.

Carlisle & Finch, 182 and 184 Elm street, Cincinnati, O., have bought out the entire repair shop of the General Electric Company in that city, and have assumed all their business in the line of repairing armatures and electrical machinery. This firm also has facilities for manufacturing electrical specialties.

Mr. T. E. Crossman, official stenographer to the National Electric Light Association and many other associations, has opened offices in the Franklin Trust Building, 166 Montague street, Brooklyn, N. Y., where he will be ready at all times to perform stenographic work of every description. The ELECTRICAL REVIEW has always found Mr. Crossman careful, accurate and conscientious in his work.

The Electrical and Mechanical Engineering and Trading Company, J. H. Vail, president and chief engineer, 44 Broad street, N. Y., have recently issued some "facts of interest" to electric lighting and railway companies, making mention of the methods of this company. With a gentleman of Mr. Vail's standing and ability at its head, the work of this company may be entirely relied upon.

The New Jersey Zinc and Iron Company, at Newark, N. J., have placed the order for the iron roofs on their new buildings with the Berlin Iron Bridge Company, of East Berlin, Conn. The furnace room will be 50 feet wide and 400 feet long, made entirely of brick and iron. The engine room, fan room and boiler room will be 60 feet wide and 187 feet long—the engine room covered with slate, and the fan room and boiler room covered with corrugated iron.

Henry G. Issertel, electrical engineer of New York, formerly of the A. B. C. Company, has taken a new departure and is now known as an electrical broker, a field hitherto unexplored by the electrical fraternity. In this capacity Mr. Issertel proposes to keep in touch with the progress of the times and well informed as to prices, and to place the orders of his customers with manufacturers of the various electrical specialties] having the best articles at the lowest prices.

Chas. A. Schieren & Company, 45 Ferry street, New York, have received a letter from the Risdon Iron and Locomotive Works, San Francisco, Cal., in which they quote one of their customers, the president of the Union Ice Company, as follows:

"The two double perforated electric leather belts I purchased of you last Summer for the Union Ice Company's factory, Mentone, San Bernardino County, Cal., are doing splendidly. The 20 inch belt on 26 inch motor pulley has a velocity of about 5,000 feet per minute. The 30 inch belt has a velocity of about 3,000 feet per minute. Each transmits 1,500 horse-power and are as perfect as when first put on."

The Consumers' Electrical Supply Company, of No. 13 Park Row, New York, are having remarkable success with their flush switches, D. P., S. P., three way and commutator styles. The low prices at which they are sold astonish the most experienced buyers. The "Cesco" carbons for arc lights, are also away down in price and are being generally adopted throughout the Central and the New England States. Their new "Cesco" battery crystals take the place of sal ammoniac in Leclanche batteries, and are not only more efficient as a battery salt, but are considerably cheaper. Write for prices and any information on electrical matters generally.

The Hayden-Booker Manufacturing Company, 2140 De Kalb street, St. Louis, Mo., has been formed to manufacture all classes of galvanic batteries and to deal in everything in the battery line. The president and manager of the company is Mr. M. M. Hayden, who is well known to the electrical fraternity as the manager of the battery department of the Law Telephone Company and as president and manager of the Law Battery Company, from which latter positions he resigned on February 15. The Hayden-Booker Manufacturing Company are organized as manufacturers and will make their own carbons, zincs, covers and jars, and, consequently, will be satisfied with the first or manufacturer's profit. Mr. Hayden's experience will, doubtless, prove of great value to the new company, which is already in the market with a line of improved batteries.

The Westinghouse Electric and Manufacturing Company.—The following notice has been sent out from Pittsburgh: We wish to call the attention of our friends and patrons and those interested in electrical matters generally to the establishment of our San Francisco agency. About March 1 we opened an office in the Mills Building, and will carry a stock of our well-known standard supplies to satisfy immediate wants. Those interested in long-distance power transmission can there obtain information and estimates from our engineers. Each transmission proposition is an engineering problem in itself, and we will take pleasure in furnishing information on the subject to all inquirers. The excellence of our railway, lighting, mining and other apparatus merits the consideration of contemplating purchasers. Our representative will be Mr. H. A. Russell, assisted by Mr. R. B. Elder, both of whom are already well-known in the electrical business on the Pacific Coast.

The Central Electric Company, Chicago, have placed their house goods and retail departments in charge of Mr. W. R. Princkard, who has had several years' experience in those lines, and is personally well-known to the electrical fraternity. This concern reports that their business in these two departments is increasing so rapidly that they find it necessary to increase their facilities. One of the most important specialties in the house goods department is the line of Edison-Lalande batteries, physicians' supplies, battery fan motor outfits, etc., manufactured by the Edison Manufacturing Company, and for which the Central Electric Company have special selling arrangements. This company also reports that they are in receipt of the following communication from one of the leading electric light companies in the country:

"We are obliged to you for your calendar for 1894. We were on the point of writing for one, because it was the most sensible and complete one we had last year, and we hoped you were printing one of the same style for this year."

The Central calendar is certainly a complete electrical calendar, and anyone in the trade who has not received one should request the Central Electric Company to forward one at once.

Electric Propulsion on Canals in England.

A correspondent writes: "The experiments which have taken place in the United States as regards the electric propulsion of boats on canals have attracted much attention in England, where the canals are in a languishing state. Already engineers are turning their attention to the question of improving the system of haulage on canals, and the other day I saw some particulars of a new system which has been designed and which will shortly be made public. At present I am not allowed to divulge any particulars."

ELECTRIC LIGHT FLASHES.

Albion, Neb., is agitating the subject of electric lights.

New Athens, Ills., is making an effort to get electric lights.

The new electric light plant at Alma, Wis., was destroyed by fire on March 2.

The New Haven, Conn., Electric Light Company is soon to begin an addition to its plant which will double its capacity. Two new 200 horse-power engines will be added at its Grand avenue plant, which will give altogether 700 horse-power there.

Half the city of Oshkosh, Wis., was in darkness a few nights ago as the result of a dispute between the Oshkosh Electric Light Company and the city council regarding the price of lighting. The result is that the aldermen are more determined than ever to build a lighting plant, if possible.

A special committee of the Buffalo, N. Y., board of aldermen has agreed to report favorably to the common council a measure for the construction of an electric light plant from which the city will furnish its own light. An appropriation of $100,000 is recommended. The city now pays $370,000 a year for light.

At a recent meeting of the stockholders of the Consolidated Telegraph and Electrical Subway Company, of New York city, these directors were chosen: William H. Woolverton, Charles F. Cutter, Robert M. Galloway, Edward Lauterbach, Frederick Lovejoy, Edward J. Hall, John Jamison, Edgar L. Ridway and E. E. Gedney.

Mr. J. L. Donovan has bought the electric light plant at Lampasas, Tex., from the Southern National Bank, of New York, and has put a force of men to work moving the plant from its present quarters to the banks of the Sulphur Fork, where he proposes to run it by water-power. He has recently built a rock dam across the creek at a cost of $5,000.

At the annual election of the Edison Electric Light Company, of Schenectady, N. Y., the following officers were selected: President, John Kruesi; vice-president E. Griffin; secretary, S. D. Greene; treasurer, Edward Clark; comptroller, J. P. Ord; assistant treasurer, C. S. Medbury; trustees, John Kruesi, Eugene Griffin, O. T. Crosby, S. D. Greene, J. R. Lovejoy, J. R. McKee, T. A. Edison, J. P. Ord, C. A. Coffin.

The New York Board of Electrical Control recently received a communication from Deputy State Controller William J. Morgan, stating that as the Board of Electrical Control is under the supervision of the City Civil Service Board the State cannot pay the salaries of its employés who are under the civil service laws. There are about 15 inspectors, who have been waiting for their salaries for the last two months. Both the city and State have refused to pay them. The board instructed the Corporation Counsel to institute a friendly suit against the State Controller for the payment of the salaries, and have the courts decide by whom they are to be paid.

The new Broad street station of the Pennsylvania Railroad at Philadelphia when completed will contain over a hundred miles of concealed electric wiring. About 53 miles of wire will be required for the electric lighting alone, which will be done with about 10,000 incandescent lights. Not a gas pipe can be found in the great structure, the sole reliance being on the electric lights. In the waiting room alone there will be 2,500 lights, located principally in the ceiling, where they will be arranged in rows about the large square panels. The office building will require about 6,000 lights, while the other 1,500 will be used in the rooms on the ground floor, retiring rooms, dining rooms and restaurant.

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